17.B.

A

SYSTEM

OF

MINERALOGY,

FORMED CHIEFLY

ON THE

Plan of Cronstedt.

VOL. II.

By J. G. SCHMEISSER,

F. R. S. &c.

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PREFACE.

I HEREWITH deliver the ſecond Volume of the Syſtem of Mineralogy.

I have endeavoured throughout the Work, to merit the candour and liberality of a diſcerning Public, by executing as much as my knowledge enabled me to do, and as the ſubject ſeemed to demand. I have furniſhed the Reader with the principal parts of the Science of Mineralogy, with the difcoveries and improvements which have been made, of late years, on the Continent, and with fuch as I could add from my own induftry and knowledge; and I hope, I have fully illuftrated the importance and utility, which this Science fo juftly claims.

To improve this Work in proportion as my knowledge may increafe, will be my future endeavour. In this, I intend to follow the plan, of which, I have given a fketch in the Appendix to this Volume, and of which, the Continuation fhall follow in the form of a Supplement. This Continuation I fhall publifh from time to time, in Numbers, according to the advancements and discoveries which may be made in the Science;

Science; by this means, the Reader will come to poffefs all the new and progreffive obfervations, difcoveries, and improvements, almoft as foon as they are publifhed abroad; particularly thofe contained in the Journal called *Bergmanifcher Journal*, and the Chemical Journal of Crell——Works, which convey very ufeful information on fubjects relating to Chemiftry and Mineralogy, and hence, I hope, not unacceptable to thofe who purfue thefe ftudies. I intend that the firft Number fhall contain an account of fuch mineral fubftances, and fuch improvements, as have been lately publifhed abroad, and were not in my poffeffion when I finifhed this Work; feveral of which, I have found in fome excellent books of Gmelin and Suckow, and other eminent authors in Germany.

Various new obſervations, and an account of ſome newly diſcovered mineral products of theſe Iſlands, and particularly of Ireland, I expect we ſhall be informed of, by the ingenious and excellent chemiſt, Mr. KIRWAN, in his new edition of Mineralogy. To him, to the late Cronſtedt—Klaproth—Suckow—Monge—De la Metherie——Born——Gmelin—Werner—Blumenbach—Weſtrumb—Heyer—Chaptal—Furcroi—and ſeveral other eminent Authors, I acknowledge my ſincereſt thanks, for the inſtruction I have derived from their Publications.

It will be obvious from the nature of my new Plan, that I ſhall have occaſion to tranſpoſe ſome ſpecies in the ſyſtem; as the tremolit—mica—and ſeveral others.

I ſhall

I ſhall alſo make ſome alteration, and give a more full account of the ſubſtances which come under the head of rocks, or mineral ſubſtances, whoſe component parts are variouſly mixed, or blended together; as I have had lately ſome, and ſhall ſoon have greater opportunities, of exploring that ſubject myſelf, with greater attention; for which opportunities, I acknowledge with pleaſure, that I am greatly indebted to a valuable Friend and a countryman of mine, whoſe noble character and benevolent deeds towards the relief of misfortune and indigence, are greatly felt and acknowledged in his own country; while his laudable intentions, and indefatigable ardour to collect, cultivate, and promote the uſeful ſciences, will hardly eſcape the attention of the great body of philoſophical men in this country, whoſe

whoſe zeal for ſcience, and for charity, is ſo congenial with his.

I alſo beg leave to mention, that ſince this Publication, I have paid much attention to the ſubject which relates to chemical attraction (generally called affinities) of bodies, and that I have finiſhed a new Table, exhibiting ſuch; this I ſhall inſert in the Work I have now finiſhed, and ſhall call it EXPERIMENTAL CHEMISTRY. It is finiſhed chiefly after the doctrines of the new Theory. In this, I have procured myſelf the advantage of having repeated moſt of the intereſting experiments, and have improved and added ſeveral new aſcertained facts, and ſome obſervations of my own, which I have drawn from well eſtabliſhed facts, as far as I could do it from the preſent knowledge we poſſeſs of bodies examined

examined by chemical experiments. This Work, I wiſh to be underſtood, is not meant to give an account of all the different Theories, and their hiſtory, as theſe may be better taught occaſionally in Lectures, or may be read in ſeveral books publiſhed on that ſubject, to which I refer. It is merely to be conſidered as a Collection of the beſt eſtabliſhed Facts in Chemiſtry, arranged in an order, which from experience, I thought the moſt proper for beginners in Chemiſtry, and eaſieſt to be underſtood. It will be very uſeful for ſtudents who attend Lectures, and even for ſuch who wiſh to make application of their obtained knowledge, in performing experiments themſelves. The method which I have adopted, will not interfere with the utility of attending Lectures on Chemiſtry, though theſe

may

may be, perhaps, arranged in a different manner, as the facts will always keep their value. It will contain likewife, an explanation of the beft eftablifhed methods of making chemico-pharmaceutical preparations, with an advantage both for the operators, and for phyficians, who are to make ufe of them. Many medicines, or preparations, have loft their reputation, owing to the improper manner of preparing them. I have alfo noticed the methods of difcovering the adulterations of the different articles. The whole will be comprifed in one Volume.

Before I conclude, I beg leave to mention a fact which I lately afcertained, and which relates to the experimental part of this Work, in making the chemical analyfis of minerals. It is the method

method of ſeparating argillaceous earth from magneſia, when both are contained in one mineral, which hitherto could not be done without great difficulty, I mean, to any nicety.

When both are in a ſolution of muriatic acid in a ſaturated ſtate, the argillaceous earth may be perfectly ſeparated by ammonia ſaturated with fixed air, as this will only ſeparate that earth, and the magneſia will be retained in ſolution; the magneſia may then be ſeparated, by decompoſing the ſolution after being boiled, with a ſolution of pure potaſh or ſoda.

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SECOND PART

OF THE

SYSTEM OF MINERALOGY.

CLASS IV.

OF

METALS OR METALLIC SUBSTANCES.

THESE ſubſtances are, according to the old theory, conſidered as compound bodies compoſed of the metallic earth and phlogiſton, or the matter which gives metals their luſtre, and renders them more or leſs inflammable; and, according to the new theory, the metals are underſtood to be ſimple bodies, or bodies which cannot be decompoſed, but which are liable to be changed by other bodies. When united to other

other bodies, they can always be recovered from any ſtate. The new theory ſeems to turn out more favourable reſpecting certain facts; yet neither of them is ſufficiently inveſtigated and proved, as to explain all the means and operations, which nature may have employed to exhibit the metals in the various ſtates, in which they are found in different parts and ſituations of the Earth.

Metals, in general, are diſtinguiſhed from all other known mineral products, by certain peculiar properties: They have a peculiar luſtre; they exceed all other bodies by their ſpecific gravity, denſity, ductility, and malleability. They are not ſoluble in pure water, but all of them are ſoluble in nitric and muriatic acid, either in the one or in the other ſeparately, or in both mixed together.

Metals all melt in the fire, but each of them ſeems to require a different degree of heat for fuſion; ſome of the ſemi-metals, as the wolfram, uranium, and molybdena, require a very intenſe heat, or ſome additional ſubſtances to render them more fuſible. No metals are ſo hard as to ſcratch glaſs; moſt of them are inflammable, or burn in pure air or oxygen-gas, by the aſſiſtance of heat, but they certainly differ from the real inflammable and combuſtible

combuſtible ſubſtances; ſince none of the metals can be converted into the ſtate of air or gas, when burnt in pure air or oxygen-gas, like charcoal, &c. which are conſumed, and enter during the combuſtion, into the compoſition of permanent gas, viz. fixed air, or carbonic acid gas; nor do the metals form perfect acids when expoſed to heat and pure air like ſulphur; they only abſorb the baſis of the pure air, or the oxygen, and a certain portion of moiſture, from the ſurrounding atmoſphere, in which they are heated or burnt, and which alters their ſtate and appearances, and occaſions an increaſe in their weight.

Metallic ſubſtances are generally divided into two general claſſes; namely, into *real metals*, and *ſemi-metals.*

The firſt kind are diſtinguiſhed by their malleability, the coheſion of their particles not being deſtroyed by hammering. Some are found unalterable in the atmoſphere, and undeſtructible in common fire, ſuch as *platina*, *gold*, and alſo *ſilver*, and theſe are called *perfect* or *noble metals.* Whilſt others, which undergo a greater or leſs alteration when expoſed to heat, or even only to the atmoſphere, as *copper*, *tin*, *iron*, *lead*, *mercury*—are called *imperfect metals.*

The ſecond kind, or the *ſemi-metals*, viz. *antimony*, *cobalt*, *biſmuth*, *mangancſe*, *wolfram*, *molybdena*, *uranium arſenic*, are more or leſs brittle, and not malleable; they alſo undergo different changes when expoſed to heat and air; and ſome of them may even be volatiliſed by heat, ſuch as *arſenic* and *antimony*.—*Zink* has alſo been ranked with the ſemi-metals; but it belongs on account of its great degree of ductility, more properly to the imperfect metals, as it may be extended or brought into the ſtate of thin plates by preſſure.

The metallic ſubſtances in general poſſeſs certain qualities, in which they exceed one another; thus, reſpecting their different degrees of denſity or ſpecific gravity, they may be placed in the following order: Firſt, platina, gold, wolfram, mercury, lead, ſilver, biſmuth, copper, arſenic, iron, cobalt, uranium, tin, manganeſe, zink, and antimony.

Secondly, with regard to tenacity—gold, iron, ſilver, copper, tin, lead, &c.

Thirdly, with reſpect to hardneſs—iron, platina, copper, ſilver, gold, tin, lead.

Fourthly, as to malleability—gold, ſilver, platina, copper, iron, tin, lead.

Fifthly, with reſpect to fuſibility—mercury, tin, biſmuth, lead, zink, antimony, ſilver, gold, arſenic, cobalt, copper, iron, and platina.

Metals,

Metals, when melted or fuſed, and expoſed to cool gradually, always exhibit a convex ſurface, and occaſionally cubical or octoedrical cryſtals, which figure is peculiar to all metals.

Moſt metals have an affinity to each other, and unite in a greater or leſs proportion when in a fluid ſtate; but they have no affinity, or cannot combine with earths, except they are previouſly brought into the ſtate of calx or oxyd.

All metals, except platina, gold, and ſilver, are liable to undergo an alteration, when expoſed to heat, and air, that is, to ſuch air as is neceſſary for the ſupport of life and flame, by which the metals loſe their luſtre, coherency, malleability, and the quality of uniting to each other by fuſion; they become more or leſs friable, exhibit different colours, and their weight is encreaſed, which, according to the new theory, has been accounted for by the abſorption of oxygen.

The increaſe of weight has been found different in different metals; hence the following table has been formed, exhibiting the different increaſe of weight: Mercury increaſes 0,6.—Biſmuth 0,8.—Silver 12.—Lead 15.—Copper 19.—Cobalt 20.—Antimony 21.—Zink 25.—

Manganeſe 30.—Iron and tin 40. The metals are then called calxes, or oxyds of metals.

Some metals undergo that alteration, when expoſed to the temperature of the atmoſphere; others require more or leſs heat; and a few of them, ſuch as the perfect or noble metals, are not acted upon by the atmoſphere, nor by water nor heat, which explains the reaſon why thoſe metals are almoſt always found in their perfect metallic ſtate, and when they are brought into that ſtate by other operations, they can be recovered by the mere application of heat, which is, according to the new theory, explained, from the weak affinity of theſe metals to oxygen.

When metals are brought into the ſtate of calxes or oxyds, they are rendered fit for entering into the mixture of different earths, and compoſition of different ſtones, in which they occaſion an alteration, both with reſpect to coherency and colour.

Moſt of the metals have an affinity to ſulphur, except gold and platina, and therefore enter into combination; by means of which, the metallic ſubſtances are alſo altered, and exhibit an appearance different from their original one, and alſo different from their afore-mentioned ſtate. They become more or leſs brittle, according

to

to the quantity of ſulphur with which they unite, and alſo according to the different degrees of intimate combination.

Certain metals, when in the ſtate of calx or oxyd, and united with ſulphur, occaſion, when expoſed to moiſture and the atmoſphere, an alteration in the nature of the ſulphur which approaches gradually to the ſtate of acid, and which, according to the new theory, is accounted for by the abſorption of oxygen, which is conſidered as the acidifying principle, and which forms acids when combined with acidifiable ſubſtances, ſuch as the ſulphur; in which caſe, that acid, namely, the ſulphuric acid, acts again upon the metal, with which it was united and forms a new body, which, when united with a proper proportion of water, exhibits the metal in the ſtate of ſalt; hence the origin of the vitriols of iron and copper, which are found in the earths, may be explained.

Metals in general are found in the ſtate of neſts, and veins alſo intermixed in different ſtones, which form gangues in certain mountains or rocks. The veins are more or leſs inclined to the horizon; and the degrees of inclination have cauſed them to be diſtinguiſhed by the names direct, oblique, inclined, or level veins, according to the angle they make with the horizon. The part of rock which rests upon the veins, is called the roof; and that part upon which the vein rests itself, is called the bed of the veins. They possess a greater or less degree of continuity, according to which they are distinguished by the names of continued or broken veins; and when the ore is found in spherical parts or masses, from space to space, these masses are called stock-work, or bellies.

The nature of the stones which compose mountains, is the best indicator of ores; and all the other marks are very imperfect, and most of them ridiculous.

We know that granit, and other rocks of a primitive origin, seldom contain metals, or the mountains of modern formation; but it is found, that mountains of a secondary formation, are the chief matrixes in which metals exist. The mountains of gneiss, or shistous rocks, contain the richest veins of metallic substances; quartz, calcareous stones, and heavy spars, are also good indicators of ores.

On account of the afore-mentioned different states in which metals are found, in or on the surface of the earth, they may be brought under the following divisions.

DIVISION.

DIVISION I.

NATIVE METALS AND SEMI-METALS.

This denomination ſignifies, when metallic ſubſtances are found in the earth in the metallic ſtate, poſſeſſing and exhibiting all their peculiar properties and appearances. They are in that ſtate not united to, nor altered by any other ſubſtance. So we find platina, gold, ſilver, mercury, copper, antimony, arſenic, cobalt; iron, tin, and lead, are alſo ſuppoſed to have been found in that ſtate, but very rarely.

Platina is always found in the metallic ſtate; gold alſo moſt generally. The other metals, as ſilver and copper, &c. are frequently found in the ſtate united with ſulphur, or in the ſtate of calx or oxyd.

When metals are found in their metallic ſtate, they are eaſily diſcovered by their properties. They are extracted or ſeparated from their matrixes, firſt, by reducing them, together with the matrixes, to ſmall particles by pounding; after which they are waſhed by ſtreams, in order to ſeparate ſuch heterogeneous particles, from the metallic, as from their inferior

inferior gravity, can be washed away: The thus separated, or remaining metallic particles, are then dried, and further extracted; either by the process of amalgamation, as gold and silver, which easily unite with mercury, and from which the mercury can be separated again by distillation, in earthen retorts, or distilling vessels, on account of its volatile nature.

The gold or silver which remains in the distilling vessel, is further freed from other imperfect metallic substances by the process of cupellation, which is done by uniting the gold or silver with a certain proportion of lead, and exposing it in small quantities upon small cupels, or tests chiefly made of bone ashes, to such a degree of heat in an assaying furnace, (in which the heat is applied from the upper part) so as to occasion the lead to unite with the heterogeneous imperfect metal, with which it vitrifies, soaking into the pores of the test, and leaving the nobler metal, as the gold or silver in its pure state behind. Sometimes this process is repeated, if the gold is found not quite pure.

The other metals, when in the metallic state, (and sometimes also silver) are separated from their matrixes, by the process of fusion or smelting; in which, is first to be observed, the different degree of heat which certain

certain metals require for fuſion, without deſtroying them ; ſecondly, the nature of the matrixes, according to which, certain materials muſt be added to render the matrix more fuſible, ſo that the metallic particles may unite, and be eaſily ſeparated by virtue of their ſuperior gravity. Or, in other caſes, ſubſtances are added to ſcorify the heterogeneous ſubſtances, and to ſeparate thus the metallic particles. Or ſuch ſubſtances are added, as prevent the effect of pure air upon thoſe metals, which eaſily calcine or abſorb oxygen, when expoſed to heat, ſuch as charcoal.

Lime-ſtone and quartz are frequently employed in ſmelting different ores.

DIVISION II.

METALS AND SEMI-METALS UNITED OR MINERALISED BY SULPHUR OR ARSENIC.

In this ſtate the metals have loſt their coherency, malleability, and peculiar luſtre. They are more or leſs brittle, and exhibit a luſtre different from their original one ; when they exhibit a metallic luſtre, they are generally called pyrites, ſuch as the iron, copper, and arſenic ;

arſenic, when united to ſulphur; the metals and the ſulphur are in different proportion, and different metals and other ſubſtances are frequently intermixed.

Metals in this ſtate are eaſily diſtinguiſhed by the ſulphuric or arſenical vapour or ſmell, which they emit when expoſed to heat. By a ſtrong heat, they are converted into ſlags.

The metals are ſeparated in this ſtate from the ſulphur or arſenic, by torrefaction, which is done by expoſing the previouſly pounded ores upon flat earthen veſſels, to ſuch a degree of heat, as is only required to volatiliſe the ſulphur or arſenic; whereas a greater degree of heat, would alter and deſtroy part of the metal. After which, the remaining metallic parts are further freed from the reſt of the ſulphur, either by iron, or by other ſubſtances, according to the nature of the metals. So muſt afterwards other ſubſtances be added, accordingly in order, to ſeparate the metallic parts, and to recover them, when in the ſtate of calx, by charcoal, which I have mentioned in the different ſpecies of ores.

Silver, copper, iron, tin, lead, antimony, and mercury, are frequently found united to ſulphur, but platina never, and gold very ſeldom; and then it appears to be owing to the

the admixture of iron, in a ſimilar manner, as zink ſeems to be united to ſulphur, in blende.

DIVISION III.

METALS AND SEMI-METALS

IN THE STATE OF CALX OR COMBINED WITH OXYGEN, CALLED CALCES OR OXYDS OF METALS.

How metals have obtained that ſtate, is ſtill variouſly explained.

According to the old theory, when metals were brought into this ſtate, it was ſaid, they parted with their phlogiſton, or that matter which recovers them again, when afterwards employed, through the means of ſuch ſubſtances as contain it; according to the new theory, it is ſaid, the metals have combined with oxygen, from the ſurrounding atmoſphere, or from other ſubſtances as contain the oxygen, ſuch as water and acids, and have thus obtained their additional weight.

The metals in this ſtate, are more or leſs friable, have an earthy appearance, and exhibit different colours, but no luſtre. They are eaſily acted upon by acids, and enter into the mixture

mixture of other ſubſtances, in which they produce different colours.

The metals are recovered from this ſtate, either by mere heat or by charcoal, when they regain their luſtre, coherency, and their other properties.

Certain metals when in the ſtate of calx, are found united to fixed air, or carbonic acid; and in that caſe, they exhibit often a regular ſhape.

In the ſtate of calx, or oxydated, we find iron, cobalt, copper, arſenic, biſmuth, antimony, zink, manganeſe, tin, lead, and mercury.

DIVISION IV.

METALS AND SEMI-METALS COMBINED WITH ACIDS, OR METALLIC SALTS.

When metallic ſubſtances are in this ſtate, they bear again a different appearance from all the aforementioned ſtates; when united with a ſufficient quantity of water, they are exhibited in regular cryſtals. They have a different colour, according to the different metals and acids of which they are compoſed.

In

In the ſaline ſtate, metals are more ſeldom found than in any other, and only a few of them, ſuch as the vitriol of iron, copper, and zink, are employed for uſeful purpoſes, and theſe are found in greater quantities than the other metallic ſalts ; but they are not uſed for the purpoſe of extracting or ſeparating the metals from them.

Of metals in the ſtate united to acids, we find

1. The *ſulphuric* or *vitriolic acid* united to copper, iron, zink, ſilver, and mercury.

2. The *muriatic* or *marine acid* united to ſilver, antimony, mercury and copper.

3. To *phoſphoric acid*, iron, lead.

4. To *arſenical acid*, cobalt, lead, copper, and ſilver.

5. To *carbonic acid* or *fixed air*, iron, lead, cobalt, copper, mangane$ſ$e.

DIVISION I.

Perfect or Noble Metals.

GENUS I.

PLATINA.

This metal was firſt notified in the year 1748, by *Don Antonio Ulloa*, and *Charles Wood*, who brought

brought it from Jamaica, and made experiments upon it, which were publiſhed in the Philoſoph. Tranſact. for the year 1749 and 1750.

Meſſrs. *Scheffer*, in Sweden; *Lewis*, in England; *Margraaf*, in Pruſſia; *Macquer*, *Baumé*, *De Buffon*, *De Milly*, *De Liſle*, *De Morveau*, and *Baron de Sickingen*, have ſucceſſively made reſearches on this metal, in order to diſcover its nature ſtill more, and to aſcertain its ſuperior qualities.

Platina has hitherto been found in America, near the village Choco. In the environs of the river *Pinto*, in *Peru*; in the ſand of ſeveral rivers in America, viz. the river *Bogoda*, at Santa Fé, near Carthagena; near the mountains of the diſtrict of *Novita* and *Cytara*, in South America, it has been found mixed with auriferous ſand.

In all thoſe different places, the Platina is found always in its metallic ſtate, and there are no different ſpecies and varieties known yet. It is found in the form of ſmall grains, or flat pieces, very ſeldom exceeding the ſize of a pea. The grains appear generally ſilver-white, or have rather the colour intermediate between that of ſilver and iron. It is from the reſemblance which it bears to ſilver, with reſpect to colour

colour or luſtre, that it has been called Platina in the Spaniſh language.

It is never found pure, but always more or leſs mixed with iron, and frequently alſo with gold; ſometimes it contains ſo much iron, as to be attracted and taken up by the magnet.

In the ſtate in which Platina is brought to us, we often diſcover a little mercury adhering to it, ariſing from the proceſs of amalgamation, which the platina-grains have been expoſed to, in extracting the gold from it; but from which it is eaſily freed by expoſure to heat.

From iron it may be freed either by boiling it, when previouſly reduced to fine particles, or with muriatic acid, which takes up the iron, and leaves the Platina behind; or the Platina may be mixed with ſal ammoniac, or *muriate* of *ammonia*, and expoſed in a glaſs veſſel to ſublimation, by which means the ſal ammoniac, being volatile by heat, leaves the Platina, and carries the iron parts, which it has alſo rendered volatile, along with it into the upper and cooler part of the ſubliming veſſel, which is ſeen by the yellow or orange colour of the ſublimed ſalt; this proceſs muſt be repeated, until the ſal ammoniac ſublimes colourleſs.

Platina, when pure, is the heavieſt and moſt refractory of all metals; it undergoes no alteration by expoſure to the atmoſphere; it is unalterable in fire or in any heat, which can be produced in common furnaces, and requires a very vehement heat to render it even liquid; but it may be eaſier fuſed upon charcoal, by the aſſiſtance of oxygen-gaz, or pure air; or by means of a large burning glaſs.

It reſiſts the action of all acids, except the nitro-muriatic and ſur-oxygenated muriatic acid, in which it is perfectly ſoluble, by the aſſiſtance of heat; and when in the ſtate of ſolution, it may be eaſily diſcovered by the precipitate which it occaſions, when muriate of ammonia or ſal ammoniac be added, in which it differs from gold. The ſolution of Platina exhibits alſo a deeper yellowiſh brown colour than the ſolution of gold, and gives a brown colour to the ſkin.

On account of its being very difficult to melt, it is neceſſary to mix it with other ſubſtances which renders it more fuſible; and by which means it becomes alſo malleable. Mr. Achard has recommended us to take equal parts of platina, white arſenic, and cream of tartar, and to put the mixture into a crucible well luted, which is then to be expoſed for one

one hour to a very ſtrong heat, that will fuſe the Platina; but in this ſtate it is brittle, and muſt be expoſed under a muffle in a furnace, in order to ſeparate the arſenic.

Veſſels of Platina may be made by fuſing the Platina with arſenic, and caſting the melted maſs; after which, the arſenic is ſeparated again in the afore-mentioned way by heat.

Mr. Morveau ſubſtitutes the arſeniate of potaſh, with advantage, inſtead of ſimple arſenic; he alſo melts Platina by a flux of powdered glaſs, borax, and charcoal.

Mr. Beaumé adviſes to fuſe Platina with a ſlight addition of lead, biſmuth, or antimony.

When Platina has been diſſolved in aqua regia, and is precipitated again by ſal ammoniac, it becomes eaſily fuſible; if the precipitated Platina be mixed with phoſphoric glaſs, and melted, it may be perfectly freed from iron, and thus rendered ſuperior in quality to that which is melted with arſenic.

GENUS II.

GOLD.

Aurum. Ital. *Oro.* Fr. *Or.*

Germ. *Gold.* Hung. *Arany.*

This metal, which, from its ſuperior qualities, is conſidered as the moſt precious of all, is found in moſt parts of the earth; it is (iron excepted) more frequently found than any of the other metals, but in leſs proportion, and ſcarcely in any other ſtate than in the metallic; never in the ſtate of calx or oxyd, nor in the ſaline ſtate, very ſeldom mixed with ſulphur, but always alloyed with ſome other metal, as platina, ſilver, copper, or mixed with iron, lead, or antimony; whereby the gold, according to the proportion of the alloy, obtains a different colour, and becomes either heavier or lighter. Gold is found partly in rivers mixed with ſand, generally in the greateſt proportion nearer their origin or ſources.

It

it is ſometimes found in the vallies of metalliferous mountains, often mixed with various kinds of ſtones or ores. Peru, Spain, Tranſylvania, Hungary, and Siberia, are particularly remarkable for gold mines.

The ſtones, or matrix in which gold is generally found, are quartz, gneiſs rock, petroſilex, and ferruginous ſtones, ſeldomer calcareous ſpar, green-clay, heavy ſpar, grey, grit, &c.

As to the nature and quality of gold, when freed from all heterogeneous ſubſtances, it exhibits always a yellow colour, which is more or leſs intenſe, according to the manner in which it is wrought.

It is next to platina, the heavieſt of the metals, and exceeds them all with reſpect to malleability.

Its ſpecific gravity is generally = 19,25.

The atmoſphere and water have no effect upon it; nor is it alterable in the heat or fire which is produced in common furnaces. When expoſed to heat, called red-heat, it emits a ſea-green light, but does not melt before the heat is increaſed to 5237° Fahr. which is commonly called a white-heat. When perfectly fuſed, and ſuffered to cool very gradu-

 ally,

ally, it exhibits four fided pyramidical figures on its furface.

When melted with borax, it produces a glafs of a ruby colour.

Gold has, of all metals, the leaft affinity to *oxygen*, or to the bafis of pure air, which changes metals into the ftate of calx or oxyd; this accounts for the fact why gold is never found in the earth in the ftate of calx or oxyd.

It is not acted upon by any other acid, but by the nitro muriatic acid, commonly called *aqua regia*, or the fur-oxygenated muriatic acid, in both of which it is readily foluble; the folution being of a yellow colour, and lighter than that of platina or iron, in the fame acid.

If we add a drop of the folution of gold to a folution of tin, diffolved in the fame acid, a purple precipitate takes place.

The folution of gold alfo occafions a purple ftain upon the fkin, and is not decompofed by fal-ammoniac, or *muriate* of *ammonia*, like the folution of platina; from which it alfo differs by its being precipitable from its folvend menftruum by *fulphate* of *iron*, or martial vitriol, which occafions no precipitate in the folution of platina.

Gold,

Gold, when ſeparated, or precipitated from the acid by alcaline ſalt, in the ſtate of calx or oxyd, recovers itſelf again by mere expoſure to heat, without any additional ſubſtance, owing to its weak affinity to oxygen.

It eaſily unites with mercury, which latter has, on that account, become a good menſtruum for ſeparating gold from its ſtony matrix, upon which the mercury has no effect.

Gold does not intimately combine with ſulphur, or it has no affinity to it, which explains why it is hardly ever found in the earth united with ſulphur, and when found ſo, the mixture or affinity has been occaſioned by ſome other ſubſtance as iron, ſimilar to what we find in zink, when mixed with ſulphur.

DIVISION I.

NATIVE GOLD, *or gold in its perfect metallic ſtate; alſo called virgin gold.*

Lat. *Aurum nativum.*
Germ. *Gediegen,* or *natürlich gold.*
Fr. *Or natif.*
Ital. *Oro-nativo.*
Hung. *Termes-arany.*

In this ſtate gold is almoſt always found; however, as it is never found quite pure, but always mixed with more or lefs of another metal, or other fubftances which alter its appearance and quality, I thought it more proper to divide and defcribe the different ftates in which gold has thus been found, as varieties refpecting its alloy or admixture.

Gold with fimple alloy of metals.

SPEC. I.

PURE GOLD, *aurum nudum.*

Gold gelb, gediegen gold of *Werner.*

This kind is underftood to be the pureft ftate in which nature exhibits gold.

It has all the appearance and qualities of refined gold, and is therefore eafily diftinguifhed. It is, in this ftate, found in folid maffes of different magnitudes, and generally without any particular fhape, embodied in ftones, commonly of a filiceous nature; we find it thus in Tranfylvania—in India, &c. More frequently it is found in the ftate of fmall particles, having no determined fhape, and difperfed through different ftones, as ferruginous quartz, and metalliferous

talliferous rock, &c. It is found thus at Cremnitz—in Tranſylvania—Peru—*Schemnitz*—and Siberia. On *Schlangenberge*, in Germany, it has been found in heavy ſpar; in Sileſia, interſperſed through coals; again in the ſtate of detached grains, as in the valleys of certain metalliferous rocks, and in certain rivers in Tranſylvania—Spain—Cremnitz, &c.

Gold is alſo found in the ſtate of duſt, or in ſuch minute particles as are hardly diſcoverable by the naked eye, mixed with various kinds of ſtones and ores; in this ſtate it has been called *aurum larvatum*; it is thus found in brown hornſtone, ferruginous red jaſper, red quartz, grey clay, black ſlate, ſcaly calcareous ſpar, in galena and pyrites. The mines of Tranſylvania and lower Hungary preſent us with this ſort of gold.

Native gold is often found in different ſhapes, viz.

(a.) In FILAMENTS or FILAMENTOUS, in ſulphurated cobalt ore, on red blende, and in lamellated ſelenite with quartz; in Tranſylvania, in the Bannat of Hungary, &c.

(b.) DENTRITICAL, on green ferruginous clay, copper pyrites and quartz; in calcareous ſpar, with manganeſe and green fibrous ſhörl, as in certain

certain mines in the territories of Salzburg; in Tranſylvania and Bohemia, upon white quartz.

(c.) LAMELLATED, or in thin laminæ, in different ſtones, viz. in white quartz, in Upper Hungary and Salzburg; frequently in ferruginous quartz, grey grit mixed with mica, and in calcareous ſpar, in Tranſylvania.

(d.) WIRE-SHAPED and net-like in and on different ſtones.

(e.) Of regular figure or cryſtalliſed, viz. cubical, in three or four ſided pyramids, in four or ſix ſided columns, and in ſix ſided plates, moſtly found in Tranſylvania.

SPEC. II.

GOLD ALLOYED WITH PLATINA.

PLANTINIFEROUS GOLD.

Aurum platiniferum.

Graugelb gediegen gold of WERNER.

This kind has a yellowiſh grey colour, is harder and heavier than pure gold.

It is only found in the ſtate of ſmall grains, involved in the platina. The admixture of platina may be diſcovered by diſſolving a little in nitro-muriatic acid, or aqua regia, and on adding muriate of ammonia, or ſal ammoniac to it, which precipitates the platina, and leaves the gold in ſolution.

SPEC.

SPEC. III.

GOLD DISTINCTLY ALLOYED WITH SILVER.

Argentiferous Gold.
Aurum argentiferum.
Aurum nativum electrum.
Meſſing-gelbes gold of Werner.

It has a pale yellow colour or luſtre, ſimilar to that of martial pyrites.

It is alſo lighter than pure gold.

This kind is not, or very ſeldom found in maſſes, generally diſperſed through certain ſtones, either in the ſtate of ſmall particles, or in lamellæ, filaments, and in ſix ſided plates. It may be eaſily diſcovered by digeſting it with nitric acid, which takes up the ſilver, and leaves the gold behind.

DIVISION II.

Gold alloyed with other metals, and mixed with ſulphur or arſenic.

The admixture of arſenic or ſulphur may be eaſily diſcovered by expoſing a little of the ore to the blowpipe, when the vapours which are diſengaged, indicate the ſulphur or arſenic.

SPEC.

SPEC. IV.

GOLD ALLOYED WITH SILVER AND MIXED WITH SULPHUR.

Bismuthic Gold.

Aurum bismuthicum.

Germ. *Weiss gold-erz.*

It may be assayed by extracting the bismuth and the silver with nitric acid ; separating the bismuth by diluting the solution with a sufficient quantity of water, and afterwards extracting the ore, by aqua regia, or nitro-muriatic acid, which takes up the gold, and leaves the sulphur behind.

It is found solid, and in needle shaped crystals, scattered through certain stones ; as to its external appearance, it is whitish, a little inclining to brass yellow ; it has a strong lustre, a lamellated texture, and is soft. It contains generally 18 parts of gold, 6 of silver, and the rest bismuth and sulphur.

It is found in Francistolle at Offenbanya, in Transylvania.

SPEC. V.

GOLD MIXED WITH A METAL NOT YET ASCERTAINED, AND A SMALL PORTION OF ARSENIC AND NICKEL.

Born. *Cath. Rais.*

It has a brilliant white lustre, a lamellated texture, sometimes so compact as to resemble

the

the texture of ſteel. It is found in lithomarge and quartz, ſometimes mixed with ſulphur, whereby it obtains a blackiſh or tarniſhed appearance, and a granular texture; it is brittle, ſo as to be eaſily reduced to powder; it crackles when firſt expoſed to the flame of the blowpipe, but melts ſoon after like lead, and diſſipates gradually in the ſtate of white fumes, leaving behind the ſmall portion of gold.

Arſenic and ſulphur are ſufficiently diſcoverable by the ſtrong ſmell which this ore emits when torrified.

Its matrix is generally quartz and metalliferous rock.

Sometimes this ore exhibits dentritical figures compoſed of ſmall, flat, ſhining priſmatic cryſtals, which reſpecting the peculiar diſpoſition of the cryſtals, has been called character-gold. *Aurum graphicum.* It is ſometimes found in the ſtate of filaments diſpoſed in a parallel direction, upon white quartz. It is found at Offenbanya in Tranſylvania.

SPEC. VI.

GOLD COMBINED WITH SULPHUR, BY MEANS OF IRON.

Gold Pyrites.

Cronſt. *Pyrites aureus.*

Ital. *Oro pirituoſo.*

In

In this kind of gold ore, the ſulphur is discovered and obtained by torrefaction; the iron by muriatic acid; and the gold by nitro-muriatic acid.

It differs from the ore in which native gold is found diſperſed through pyrites, as before mentioned, and to which it bears ſome reſemblance, as the gold in this ore has undergone a real combination with ſulphur.

It reſembles ſomewhat martial pyrites, but has a brighter luſtre.

It is found in the gold mines of Mexico, Hungary, and Adelfors, in Tranſylvania, and in Dauphiny, moſtly in quartz; ſometimes in mercurial ore, as in Hungary; in blende, of a red colour, as found at *Schwartzenberg*, in Saxony.

It yields ſometimes from 30 to 40 ounces of gold in a hundred pounds weight.

SPEC. VII.

GOLD MIXED WITH SULPHUR, ARSENIC, AND IRON.

Arsenicated Gold.

In this kind of ore, the arſenic and ſulphur are diſcovered and ſeparated by torrefaction; the iron by muriatic, and the gold by nitro-muriatic acid.

It

It has a yellow colour, and a fibrous texture. It is found in the gold mines of Tranſylvania.

SPEC. VIII.

GOLD MIXED WITH SILVER, LEAD, IRON, ANTIMONY, ARSENIC.

NAGYAG GOLD ORE.

Aurum mineraliſatum najyacenſe.

Born. Cathal. Raiſ. *Or combiné avec le ſoufre, l'antimoine, l'arſenic, le plomb, le fer, & l'argent.*

The ſilver and lead may be ſeparated by nitric, the iron by muriatic acid, the gold and antimony by nitro-muriatic acid, and the ſulphur and arſenic by torrefaction.

It is only found at Nagyag in Tranſylvania. It contains ſometimes 10 ounces gold in a hundred weight.

The gold in this ore, has entered into ſuch combination with the ſulphur, and other ſubſtances, that it cannot be ſeparated from the ore, by amalgamation.

It conſiſts generally of iron black—or lead grey—ſhining lamellæ, which are flexible and ſoft enough to be cut with a knife. Sometimes it is found in ſix ſided plates. Its matrix is generally roſe coloured fieldſpar, white manganeſe,

neſe, and quartz. Sometimes blende is mixed with it.

As to the proceſs on a larger ſcale, of ſeparating the gold from its different alloys, or admixtures, and matrix; this is to be done in different ways, according to the ſtate of the gold, and according to the nature of the different ſubſtances which are found mixed with it.

When gold is in a ſtate nearly pure, as it is found diſperſed through ſtones, or mixed with ſand, it may firſt be reduced to ſmall granular pieces, together with the matrix; a table of ſeveral feet long, and one and a half broad, with ledges round three of its ſides, and pieces of cloth with a long nap nailed on the board, is placed under a gentle ſtream of water, upon which the pounded ore or ſand is thrown; by this contrivance, the lighter and heterogeneous ſubſtances are waſhed or carried off.

When the ſtuff or cloth is ſufficiently charged with the particles of gold adhering to it, on account of its ſuperior gravity, it is then collected from the board, and put into a veſſel, where it is further agitated with water, and more freed from the lighter ſubſtances. It is then mixed with $\frac{1}{10}$ of mercury, and triturated in an iron or copper veſſel containing boiling water,

water, until the mercury has abſorbed all the gold particles. The mercury thus containing the gold in ſolution, is then ſeparated, firſt from the water, next from the earthy particles, and then from the ſand, by throwing the whole upon a table placed in an inclined direction; when the mercury charged with gold, but ſtill vivid, will, when aſſiſted by a little ſtirring, or manipulation, run off the table, and leave the ſand behind. The mercury is then ſeparated from the gold, (and ſilver if any) by expoſing the amalgam in earthen retorts to ſuch an heat as will occaſion the mercury diſtilling off, which is collected again in a receiver with water, and the gold not being volatile in fire, is thus left behind, and is afterwards further freed from the heterogeneous imperfect metallic ſubſtances, by the proceſs of cupellation.

After theſe proceſſes, the ſilver, if the gold contains any, is ſeparated by reducing it firſt to very fine laminæ, and then extracting the ſilver by nitric acid, which leaves the gold behind; the ſilver may be ſeparated from the nitric acid, by muriatic acid, with which it makes luna cornua. Luna cornua is to be decompoſed again, by mixing it with ſoda and charcoal, and expoſing it to a ſufficient heat in a crucible, whereby the ſoda unites to the muriatic acid, and ſets the ſilver free.

Gold may alſo be purified by antimony, which occaſions the other metals to ſeparate.

When gold is united to platina, it may be ſeparated from it by mercury, through the proceſs of amalgamation.

When gold is found mixed with ſulphur or arſenic, and other metals, the ore muſt firſt be torrified, to ſeparate the volatile ſubſtances, after which, the remaining ſulphureous particles will be entirely ſeparated, by melting the whole with iron, and by ſcorifying laſtly the heterogeneous metallic ſubſtances by fluxes, conſiſting of tartar and nitre, which have no effect upon gold when the ſulphur is previouſly ſeparated; without this previous ſeparation, the ſulphur would unite with part of the alkali of the nitre, and make a hepar of ſulphur, which would take up a portion of the gold, and thus diminiſh the produce. The gold left by the melting with the flux, is afterwards further purified by cupellation.

When gold ore is free from ſulphur, it may alſo at once, after being pounded and waſhed, be melted with one and a half part of litharge, and three parts of glaſs, in a crucible covered with common ſalt, or muriate of ſoda. By this operation, all the imperfect metals will ſcoriſy, and ſet the gold free.

GENUS

GENUS III.

SILVER.

ARGENTUM.

Fr. *Argent.* Germ. *Silber.* Ital. *Argento.* Swed. *Silwer.* Dan. *Solvet.* Hung. *Ezüſt.*

This metal, which is the laſt in our order of the noble or perfect metals, is found in different parts of the earth, and in different ſtates. The *Erzgebürge*, or metalliferous rocks of Mexico and Potoſi, are the moſt productive; thoſe of Saxony, Bohemia, Norway, the mines of Kapnik in Tranſylvania, in the Elſaz, and at Schemnitz in Hungary, are alſo rich.

Silver when free from heterogeneous ſubſtances, reflects a peculiar white, and when its ſurface is poliſhed, a brilliant white luſtre. It has a ſolid fine texture, and is very malleable and ductile; its ſpecific gravity is = 10,000, ſometimes a little more; it is harder than gold, but ſofter and leſs elaſtic than copper; it is not altered by pure water, nor by the atmoſphere, and is almoſt unalterable in fire; but it is eafily affected and tarnifhed by hepatic air, more than any other metal. It requires near 1000 degrees of heat (Fahr. fcale) for fufion.

It difcovers almoft no affinity to *oxygen*, or in other words, it is not altered by the bafis of pure air, which explains why it is not found in nature, feparately, in the ftate of *oxyd* or calx. And when it is brought by means of chemical operations into the ftate of *oxyd*, it even then fhows a very weak affinity to the bafis of pure air or *oxygen*, as it can be freed from it by the mere application of heat, which deftroys its affinity.

But filver has an affinity to fulphur, and combines with it; in this it differs from gold and platina. In the ftate united to fulphur, it is very eafily fufible by a flight degree of heat.

Silver unites eafily with mercury, and combines with all metals except cobalt and nickel.

It is readily foluble in pure nitric acid in a great proportion, but not in muriatic acid. The latter acid feparates it from the nitric acid, when the filver appears in the ftate of needle-fhaped fhining cryftals, which are diftinguifhed by that peculiar property of turning purple or blackifh, when expofed to the fun or to light.

Sulphuric

Sulphuric acid acts only upon the silver when in a concentrated state, and assisted by heat. Finally, it does not vitrify with lead, by the process of cupellation.

It is found in the earth in different states: in the metallic state, united to sulphur or to arsenic, commonly called mineralised—and united with acids. Besides the mentioned substances, it is found alloyed with other metals, as is mentioned in the following order or arrangement, comprising the different species of silver ores.

It is observed, that wherever metallic veins are found, charged with arsenic, and joining veins, which contain oxyd or calx of iron, there are generally rich ores of silver; and almost all ores which contain iron and arsenic, contain a more or less portion of silver.

Among the matrixes in which silver is generally found, we find the *carbonate of lime*, or calcareous stones, which contain fixed air—heavy spar—quartz—sometimes stones belonging to primitive rocks, and not unfrequently mixed with cobalt, arsenic, and nickel ores.

DIVISION I.

Silver in the metallic ſtate: Malleable, ſoluble in nitric acid and mercury.

SPEC. I.

NATIVE SILVER, OR SILVER IN THE METALLIC STATE.

ARGENTUM NATIVUM.

Germ. *Gediegen-Silber.*

Swed. *Gedieget Silwer.*

Fr. *Argent natif.*

Dan. *Natürlig eller Klar Solv.*

Hung. *Termes Ezüſt.*

In this ſtate, ſilver is frequently found. It poſſeſſes thus all qualities of pure ſilver, and generally exhibits its natural luſtre. It often appears tarniſhed, as brown, yellowiſh, or greyiſh black. It is in this ſtate eaſily diſtinguiſhed from any other.

It is perfectly malleable, and ſoft enough to be cut with a knife, when it exhibits its brilliant white luſtre.

Its

Its ſpecific gravity is = 10,000

It does not emit any fumes of ſulphur or of arſenic, when expoſed to heat.

It is perfectly ſoluble in nitric acid; the ſolution is colourleſs, and the ſilver can entirely be ſeparated from that acid, by muriatic acid in the ſtate of fine cryſtals of muriate of ſilver.

It is perfectly ſoluble in, or can be taken up by mercury.

If it contains a ſmall admixture of copper, the ſolution in nitric acid obtains a blueiſh appearance, which becomes more evident, on adding a little ammonia to the ſolution.

If it contains a little gold, the ſolution in nitric acid depoſits it in the ſtate of a black precipitate. When the gold is in greater proportion mixed with the ſilver, it may be diſtinguiſhed or diſcovered by the yellow bright colour which it exhibits, and by its ſuperior ſpecific gravity, &c. In this ſtate it is called by Werner *güldiſch gediegen ſilber, argentum nativum electrum,* which kind is found in *Schlangenberge*, Siberia, and in Norway.

As to the matrix or ſtony maſſes which contain ſilver in the metallic ſtate, we find it in heavy ſpar *(ſulphate* of *baryt)*, calcareous ſtones and ſpars (or *carbonate of lime)*, petraſilex, quartz, ſteatites, lithomarge, &c. From all these ſubſtances it can be ſeparated by the proceſs of amalgamation, to which it is previouſly prepared by ſelecting or picking, pounding and waſhing, &c. ſimilar to what is obſerved in the afore-mentioned proceſs of extracting native gold by amalgamation.

Or the ſilver may be ſeparated by the proceſs of fuſion or ſmelting, after which it is freed from the adhering heterogeneous imperfect metallic particles, by the proceſs of cupellation with lead, ſimilar to the manner in which gold is refined, or alſo by melting it repeatedly with nitre.

As to the different ſhapes under which nature exhibits occaſionally native ſilver, the following varieties are known:

It is found in ſolid pieces, ſometimes of conſiderable weight, as in *Köngſberg.*

In ſmall particles of an indeterminate ſhape, interſperſed through different kinds of ſtones, or ores, as cobalt, pyrites, &c.

In grains—dentritical—in filaments, probably originating from decompoſed vitreous or ſulphurated ſilver ore.—In lamellæ—arboreſcent; and alſo ſometimes exhibiting a regular figure, as cubical. In ſimple and double four ſided pyramids, the latter kind is found in the Elſaz.

The

The other varieties are frequently found in either of the following places:

In the metalliferous rocks (or Erzgebürge) of Mexico; of Potosi, in Peru; near Johan-Georgenstadt; Schneeberg; Freiberg; Joachimsthal, in Bohemia; Köngsberg, in Norway; Transylvania; Hungary; Harz; and near Catharinenberg, in Siberia.

The following species include the different ores, in which silver is mixed or mineralised with arsenic or sulphur, or with both. In this state the silver is called mineralised *Argentum Mineralisatum.*

It has a different appearance from its metallic state. It has lost its malleability, and is become more or less brittle; it can no longer be distinguished by its specific gravity, as that must vary, according to the sulphur and other substances, with which it has united.

The sulphur, or mineraliser, may be discovered by the smell or fumes which the ores emit, when washed or torrified, or when exposed to a gentle heat produced by the blowpipe upon charcoal. The silver cannot be extracted from these ores by the simple mode of amalgamation, nor by simple fusion, on account of the sulphur; for which reason the sulphur or arsenic must first be separated by torrifaction,

torrifaction, the remaining ore is then fused with iron, which takes up all the remaining sulphur, on account of its having a greater affinity to the sulphur, than the sulphur has to the silver; after this the silver is washed, and either extracted by amalgamation with mercury, or by melting the silver in the same state with a sufficient quantity of lead, or any other substance that will occasion a scorification of the adhering imperfect metallic substances and stones, so as to obtain all the pure silver.

The following species, is the second in order of the silver ores in general.

SPEC. II.

ARSENICATED SILVER, OR SILVER UNITED TO ARSENIC.

ARGENTUM ARSENICALE.

Fr. *Argent Arsenical.*

Dan. *Arsenikalst Solvmalm.*

Hun. *Egèrköves Ezüst ásvány.*

Born. Catal. raison. *Argent allié aver l'arsénic & une petite ou plus grande portion du fer.*

The

The arſenic contained in this ore may be diſcovered by its peculiar ſmell or fumes, which it emits when expoſed to a gentle heat; by which means the arſenic is alſo ſeparated, and leaves the ſilver behind, which is eaſily diſcovered by diſſolving it in nitric acid, and by the precipitate, which the muriatic acid, when added, occaſions.

As to colour, it generally reſembles that of tin; ſometimes it is tarniſhed; it is ſoft and heavy; it is found in ſolid pieces, and alſo in the ſtate of ſmall particles diſperſed in certain ſtones; ſometimes in the ſtate of ſcales or ſcaly, in reniform or kidney-ſhaped pieces, and alſo occaſionally cryſtalliſed or exhibiting a regular figure, as long ſix-ſided priſmatic cryſtals, or ſimple ſix-ſided pyramids.

The cryſtals are ſhining, and have a lamellated texture reſembling ſomewhat biſmuth. It yields often 20 per cent. ſilver.

It is often found accompanying native ſilver, in arſenical ores, in quartz, heavy ſpar, in red ſilver ore, and ſometimes in calcareous ſpar. As to the places where it is found, we find, Andreaſberg in the Harz, Spain, Fürſtenberg in Germany, particularly productive of the arſenicated ſilver ores.

DIVISION II.

Silver mineralifed by fulphur, more or lefs brittle, emitting fulphureous vapour when heated, not foluble in nitric acid nor in mercury.

SPEC. III.

SILVER UNITED TO SULPHUR. VITREÓUS SILVER.

Fr. *Sulfure d'argent, ou mine d'argent vitreufe.*

Germ. *Glafferz or gefchwefeltes filber.*

Ital. *Argento fulfureo.*

Swed. *Silwer glaferz.*

Dan. *Blaaes vovlet. Solvmalm.*

Hung. *Uveg ezüft áfvány.*

Cronft. and Waller. *Argentum fulphure mineralifatum.*

This fpecies is one of the richeft filver ores. The filver may be difcovered and extracted by digefting the powdered ore with nitric acid, which

which takes up the ſilver, and leaves the ſulphur behind, which laſt is eaſily aſcertained by the ſmell, when thrown upon red hot charcoal. The ſilver is ſeparated again from the nitric acid, by marine or muriatic acid.

When this ore is to be worked on a large ſcale, it may firſt be reduced to ſmall particles, and then torrified by a gentle heat, in order to ſeparate the ſulphur, after which it is melted with iron and charcoal, by which means the iron takes up the remaining particles of ſulphur, and the ſilver is left pure. The ore is generally found to be compoſed of 70 parts of ſilver, and 25 of ſulphur.

The colour or appearance of the ore is deep lead grey, greyiſh black, or the colour of ſteel; it exhibits but a ſlight mark of metallic luſtre; ſometimes it appears variegated on the ſurface.

It is found lamellar, granular, capillary, and alſo cryſtalliſed, exhibiting double four-ſided pyramids, ſometimes in cubes.

When broken it exhibits more of a metallic appearance. It is ſoft enough to ſuffer impreſſions like lead; it melts very eaſily even by the flame of a candle, into a vitreous maſs.

It is a little flexible, and may be ſomewhat extended by the hammer. Its texture is lamellar.

Its

Its ſpecific gravity is generally = 7,200.

Its matrix is either quartz, gypſum, gneiſs, pyrites, red jaſper, or metalliferous rock.

It is found in Hungary near Schemnitz, near Freiberg in Saxony, Joachimſthal in Bohemia, Kunſberg in Norway. When it is found in brown ſpar, it has been called *Tiegererz.*

SPEC. IV.

SILVER UNITED WITH SULPHUR AND ARSENIC.

RUBY SILVER ORE.

Argentum mineraliſatum rubrum.

Germ. *Roth gülden erz.*

Ital. *Argento roſſo.*

Fr. *Mine d'argent rouge.*

Dan. *Rod ſolvmalm.*

Hung. *Veres ezüſt áſvány.*

Cronſtedt, and Wallerius. *Argentum ſulphure, ferro, & arſenico mineraliſatum.*

This ore may be aſcertained by extracting the ſilver by means of nitric acid, &c. and the ſulphur and arſenic are diſcovered by the ſmell

ſmell or fumes which the ore emits when thrown upon red hot charcoal, or when torrified, the ſulphur and arſenic thereby being ſeparated.

The ore appears either ſteel grey or cochineal red, and is found of different degrees of tranſparency.

It is found in ſolid pieces, in grains, and cryſtalliſed, exhibiting ſix-ſided priſms, ſometimes, though rarely, of one inch in diameter. The cryſtals have a compact texture.

Romé de Liſle deſcribes its regular figure as a rhomboidal dodecahedron, terminating in three-ſided obtuſe pyramids; but it is generally modified ſo as to exhibit long ſix-ſided priſms with three or ſix-ſided pyramids, with angles of 70 and 110°. More varieties of figure are exhibited in the different plates of Romé de Liſle's Cryſtalligraphia.

It is ſometimes found in the ſtate of radiated incruſtation.

It may be cut with a knife; it is friable or brittle; when broken, it has a vitreous appearance, and is of a lighter colour than on the outſide. When ſcraped with a knife, the particles appear ſcarlet.

The deeper the colour of the ore, the richer it is found in ſilver.

It

It crackles when expofed to heat, but melts very eafily before the blowpipe; it detonates with nitre, when thrown into a red hot crucible, and becomes then capillary filver; it may be confidered as a mixture of realgar, or red arfenic and filver. Its fpecific gravity is generally = 5,500.

It yields by analyfis, 60 parts filver, 13 fulphur, and 27 arfenical acid.

Its matrix is quartz, calcareous fpar, pyrites, chiefly in gangues.

It is found at Andreafberg in the Harz, at Joachimfthal in Bohemia, Schemnitz in Hungary, Himmelfürz, Markirch, Manenburg, Schneeberg, and Freiberg.

SPEC. V.

PYRITICAL SILVER ORE, OR SILVER UNITED TO IRON AND SULPHUR.

ARGENTIFEROUS MARTIAL PYRITES.

Ital. *Argento piritofo.*

Germ. *Silberhaltiger Kies.*

Cronftedt. *Argentum ferro (vel etiam arfenico.) Sulphurato mineralifatum.*

In

In this ore the ſulphur is diſcoverable by the ſmell when torrified, the iron by digeſting the pounded ore with muriatic acid, and the ſilver by nitric acid, as the muriatic acid takes up the iron, and the nitric acid the ſilver, which is afterwards ſeparated again by the proper proceſs of decompoſition.

There are two kinds of the argentiferous pyrites; the one is generally yellowiſh or browniſh, containing from 2 to 15 ounces ſilver in 100 pounds weight, and is found on Kungſberg in Norway, and near Schemnitz.

Another kind which contains a ſmall portion of arſenic beſides the other ſubſtances, is called in Germany, *Weiſſerz.* It is almoſt white and ſhining; it is found ſolid and cryſtalliſed, interſperſed in gangues or veins; when ſtruck with a ſteel, it emits the arſenical ſmell. It is found in Dauphiny, in Saxony, and on *Schlangenberge.* Both varieties may be worked by torrefaction, and by ſcorifying the remaining heterogeneous ſubſtances.

SPEC. VI.

SILVER MIXED WITH SULPHUR, ARSENIC, AND COPPER.

BRITTLE SILVER ORE, BLACK SILVER ORE.

Argentum mineralisatum nigrum.

Fr. *Mine d'argent noire.*

Germ. *Spröd, Glaserz, Röschgewächs,* or *Schwarzgülden.*

Wall. *Minera argenti nigra.*

This ore may be chemically ascertained by separating first the sulphur and arsenic by torrefaction, after which the remainder may be digested with nitric acid, which takes up the metals from the solution; the silver may be separated by marine acid, in the state of luna cornua, afterwards the iron by volatile alkali, which precipitates the iron and keeps the copper in solution, from this last it may be separated by a plate of polished iron in the metallic state.

Its colour is lead grey, more generally blackish, and leaves a black trace when rubbed upon paper. It contains often 60 and more per cent. silver. When to be wrought, it is freed from the mineralisers by torrefaction, and from the other admixed imperfect metals, by scorifying them with proper vitrifiable fluxes,

fluxes, or lead. It is found in the ſtate of duſt depoſited upon various other ſilver and lead ores, in cellular pieces, or alſo of regular ſhape, exhibiting ſix-ſided priſms, ſix-ſided plates, and ſometimes lenticular cryſtals. The cryſtals are ſhining when broken.

Different varieties of this ſpecies are found near Freiberg, at Johanngeorgenſtadt, Schneeberg, and alſo near Schemnitz.

A certain kind of the black ſilver ore compoſed of ſilver, iron, ſulphur, and arſenic, which is found in the ſtate of duſt or *mulm*, coating other ſilver ores, and effervеſcing with acids, is called in German *Silberſchwärze*, *Argentum fuliginoſum*. It is found in the ſilver mines of Saxony, Bohemia, and Hungary.

SPEC. VII.

MOLYBDENIC SILVER ORE.

Fr. *Argent allié avec le molybdéne ſulfuré.*

This ore has but of late become known, and has only been found at *Deutſch-Pilſen*, in Hungary.

It is compoſed of broad ſhining lamellæ, placed one over the other, ſometimes of one inch thick, in grey argill. It gives a grey ſtain to paper, and reſembles ſomewhat common molybdena. It yields by aſſaying, 23 ounces of ſilver, in a hundred weight.

SPEC. VIII.

SILVER MIXED WITH LEAD, ANTIMONY, IRON, AND SULPHUR.

GREY SILVER ORE.

Germ. *Weiſs giltig erz.*

Fr. *Mine d'argent blanche.*

Swed. *Weiſs gylden.*

Dan. *Graae agtig Solv malm.*

Hung. *Fejér ezüſt áſvany, alſo Plackmal.*

This ore may be analyſed by extracting the antimony and iron from it, by the nitro-muriatic acid (or aqua regia) from which ſolution, the antimony can be ſeparated by merely diluting the ſolution with a ſufficient quantity of water. The ſilver and lead may then be ſeparated by digeſting the remainder of the extraction with aqua regia, in nitric acid, which takes up the ſilver and the lead,

and

and leaves the ſulphur behind. The ſilver is then to be ſeparated from the lead by muriatic acid, added to the ſufficiently diluted ſolution, which unites with the ſilver, and precipitates it in the ſtate of luna cornua, and the lead is left in the nitric acid, from which it may be ſeparated by an alcali.

The ore has a lead grey appearance. It is found in ſolid maſſes, diſperſed in, and depoſited upon different ſtones. It has a ſlight luſtre, is ſoft enough to be cut with a knife. It has never been found cryſtalliſed. It is found near Freiberg.

By decompoſition, it has yielded 20 parts ſilver, 48 lead, 7 iron, 7 antimony, and 12 ſulphur and ſilex.

Its matrix is generally white and yellow quartz, granit and fluor.

SPEC. IX.

ZINCOUS SILVER ORE.

Germ. *Zinkiſches Silver.*

Cronſt. *Argentum Zinco Sulphurato mineraliſatum.*

It is found in a black blende, having a pitch luſtre, in mines of *Schneeberg*, in Saxony; of Schemnitz; of Joachimſthal, in Bohemia.

It has a ſcaly texture, generally a globular ſhape, hence it has been called *Kugelerz.*

Sometimes it is compoſed of polyangular ſhining black or yellowiſh cryſtals, in clifts of quartz-rock.

The ſilver in this ore can be aſcertained by digeſting the ore with nitric acid, which takes up the ſilver; from which it can be ſeparated again by muriatic acid; the ſulphur is eaſily diſcovered by the ſmell which the ore emits on heating.

On analyſis, it yields generally 24 parts of ſilver, 30 of zink and ſulphur.

There are other ores which contain a ſmall portion of ſilver, but not, or at leaſt ſeldom, in a ſufficient quantity to be wrought: as galena, cobalt, biſmuth, &c. Theſe are mentioned in their proper places.

SPEC.

SPEC. X.

SILVER COMBINED WITH ANTIMONY, SULPHUR, AND SULPHURIC ACID.

Germ. *Lichtes Rothgüldenerz.*

Its colour is cochineal-red, lead grey or blood-red.

It is found exhibiting acute angular ſix-ſided pyramids, with three or ſix faces. The cryſtals are ſhining, moſtly ſemi-tranſparent and ſoft. It breaks in fragments with a conchoidal ſurface.

It yields by analyſis, 60 parts ſilver, 20,3 antimony, 11,7 ſulphur, and 8 ſulphuric acid. The ſulphuric acid may be ſeparated and aſcertained by digeſting the pounded ore with alcaline ſalt, the ſilver by nitric acid, the antimony by nitro-muriatic acid; after which the ſulphur remains behind.

SPEC. XI.

SILVER COMBINED WITH MURIATIC ACID, AND A LITTLE SULPHURIC ACID.

CORNEOUS SILVER. NATIVE LUNA CORNUA.

Germ. *Silber Horn erz*, or *Salzſaures ſilber*.

Fr. *Muriate d'argent natif*, or Argent Cornè.

It appears under different colours: pearl grey, violet grey, and yellowiſh grey. It has a lamellar texture. It is found in ſolid maſſes, diſperſed in certain ſtones—in the ſtate of hollow globular pieces, containing black ſilver duſt—in rhombic cubes—in needle ſhaped cryſtals. When in thin lamellæ, it is a little ſemi-tranſparent—it is ſoft and eaſily cut with a knife—melts very eaſily—becomes purple on expoſure to the ſun—it has a waxy luſtre.

It is found in ferruginous and argillaceous ſhiſtus.

It is found in the Elſaz; at Johangeorgenſtadt; at Schlangenberg, in Siberia; and in Mexico.

The

The beſt kind contains 72 per cent. of ſilver.

The ſilver may be ſeparated after the ſulphur is ſeparated, by decompoſing the remainder with mineral alcali or ſoda, which when mixed with it, and expoſed in a crucible to heat, combines with the acid, and thus ſeparates the ſilver in the pure ſtate.

There is another ſilver ore almoſt of the ſame compoſition, but which has a different appearance, and is called *Buttermilcherz.* It appears in the ſtate of thin white, blueiſh, and browniſh ſkins; in calcareous ſpar, formerly found at Andreaſberg on the Harz.

By analyſis, it yields generally from 20 to 24 parts of ſilver, 8 parts muriatic acid, and 67 of clay, ſometimes a ſmall trace of copper.

GENUS IV.

MERCURY.

ARGENTUM VIVUM. MERCURIUS VIVUS. HYDRARGYRUS.

Germ. *Quickſilber.*

Hung. *Kénye-Sö:*

Swed. *Quickſilfer.*

Dan. *Quegſolv.*

Fr. *Vif argent.*

Ital. *Argento vivo.*

This metal is found in different parts of the earth: in Europe, Aſia, and America. The mines of Deux-Ponts, and the Palatinate, of Almaden, in Spain, of Sweden and Bohemia, of the Province Quito, in Peru, &c. have been remarkably productive; ſo have the mines near Idria, for in one year (1663) they produced 12,000 pounds of mercury in the ſtate of cinnabar.

The mine Guanca-belica, in the Province of Quito, has produced one million pounds of mercury in one year. The mines of Saalberg, near Mafchellandfberg, 30,000 pounds weight. The other places where mercury is alfo found, are mentioned under the different fpecies of the ores in their order.

Mercury differs from all other metals, by exhibiting a fluid ftate at the common temperature of our atmofphere.

It can only be brought to a folid and malleable ftate, by an extreme cold, fuch as 39° below the freezing point of Fahrenh. Scale.

It exhibits a white brilliant luftre when pure.

Its fpecific gravity, compared to that of diftilled water, is = 13,568.

It is volatile, or can be difperfed in the ftate of almoft invifible particles or vapours, by means of a heat, in which other metals remain fixed; hence the bad effect which thofe perfons experience, who are employed in operating on mercury by heat or fire.

It is more and much readier expanded by different degrees of heat, than any other metal, which, together with its fluid nature, &c. has occafioned it to be ufed for thermometers, and other purpofes of that kind.

It

It is ſcarcely affected by the atmoſphere, nor by pure water; but it is eaſily, and much affected by hepatic air; hence it is uſed for diſcovering ſuch air in mineral waters.

It has an affinity to moſt of the metals, and diſſolves or combines readily with gold, ſilver, lead, tin, biſmuth, antimony, and zink, when in a metallic ſtate; but in a leſs degree, or with more difficulty with the other metals; with platina, cobalt, and nickel, it ſeems not to unite by any means; nor does it unite with earths or ſtones, nor metallic oxyds. It is therefore found uſeful for extracting gold or ſilver, from their ores or matrix; for dividing gold into very minute particles, ſo as to be depoſited upon the ſurface of certain other metals, as in gildings; in which the cleaned ſurface of ſuch metals is firſt coated with the mixture of gold and mercury, or gold-amalgam, and then expoſed to a heat, which volatiliſes the mercury, and leaves by that means the fine particles of gold cloſe on the ſurface of the metal; for uniting with certain metals which render it fit for coating glaſs for looking glaſſes. It combines with ſulphur, and forms, when aſſiſted by heat, cinnabar. It has an affinity to oxygen, but when combined with it, it can be eaſily

eaſily deprived of it, by the mere application of heat when in a cloſe veſſel.

It is readily ſoluble in nitric acid, from which it can be ſeparated again by copper in a metallic ſtate. When combined with muriatic acid, it makes the corroſive ſublimate; in which ſtate it can be eaſily diſcovered by mixing it with lime water, which occaſions a precipitate of an orange colour. It is found in nature in the metallic ſtate;—combined or mineraliſed with ſulphur;—united to oxygen and alſo to acids.

Its general matrix is calcareous ſpar—argillaceous ſhiſtus—bituminous ſhiſtus—ferruginous and white quartz—marle—petroſilex, &c. from which it is ſeparated by trituration and diſtillation, or when combined with ſulphur, by decompoſing it with iron, by the proceſs of diſtillation.

DIVISION

DIVISION I.

Mercury in the metallic ſtate. Soluble in nitric acid, and is ſeparable from its matrix, or admixture by mere heat, without emitting oxygenous gaz, or ſulphureous vapours.

SPEC. I.

NATIVE MERCURY. MERCURIUS NATIVUS

Germ. *Gediegen quickſilber.*

Fr. *Mercure vierge.*

Hung. *Termes eleven kényе ſö.*

Dan. *Naturlig gueg ſolv.*

Ital. *Mercurio nativo.*

Wallerius. *Mercurius virgineus.*

It is found in moſt of the mercury mines in the ſtate of ſmall globules exhibiting a bright luſtre, and all the properties of pure mercury, adhering on the ſurface of cinnabar ores, from which it is eaſily ſeparated by trituration and diſtillation.

It

It is thus found in the mines near Sahlberg in Sweden, at Almaden in Spain, at Idria, in Bohemia, in the Palatinate near Wolfſtein and Moersfeld, in the Duchy of Deux-ponts, on the mountain *Stahlberg*, and near Moſchellandsberg, &c.

SPEC. II.

NATIVE AMALGAM.

MERCURY UNITED WITH SILVER.

Germ. *Natürlich amalgam.*

It may be eaſily diſtinguiſhed by its conſiſtency, and when expoſed to heat, it parts with the mercury, and leaves the ſilver pure behind, which is entirely ſoluble in nitric acid, and poſſeſſes all the properties of metallic ſilver.

Its colour is generally the medium between tin and ſilver; it is found partly liquid, partly more or leſs ſolid, ſometimes exhibiting oblong polygons; it is ſhining, and ſoft enough to ſuffer impreſſions with the nail of a finger. It gives a creaking noiſe when cut with a knife. It is not frequently found, nor in large quantities; but if it ſhould be found, both the ſilver

ſilver and the mercury can be perfectly ſeparated from each other, after the amalgam is firſt ſeparated from the matrix, by diſtilling it in cloſe veſſels; by means of which, the mercury being of a volatile nature in fire, diſtills over into the receiver with water, and the ſilver being fixed in fire, remains behind.

Native amalgam is found on Moſchellandsberg, and Stahlberg, in the duchy of Deux-ponts; near Sahlberg, in Sweden; near Zlana, in Hungary; in thoſe mercurial mines only where the veins are attached to ſilver, which accounts why it is not found at Idria, and at Almaden, as in thoſe places no ſilver is found attached to the veins of mercury.

The matrix is generally grey indurated clay. The amalgam found in Hungary, contains generally a little mixture of lead.

DIVISION II.

Mercury in the ſtate of calx or oxyd, pulveriſible, yields fixed air when heated with charcoal in cloſe veſſels, and the mercury recovers without emitting ſulphureous vapours.

SPEC. III.

OXYD OF MERCURY. CALX OF MERCURY.

Red Native Precipitate.

Fr. *Precipité rouge natif.*

Germ. *Rother natürlicher queckſilber kalch.*

It was firſt noticed by Mr. Kirwan; it has a red colour, is compact and heavy, has a granular texture, and is generally mixed with globules of mercury.

When expoſed to heat in a cloſe veſſel, it yields oxygenous gas or pure air, a little fixed air, or carbonic acid gas, and the mercury becomes recovered.

It was found mixed to ſand, near Alicante; in the mercury mines at Idria, and Buſachino.

DIVISION III.

Mercury mineraliſed by ſulphur, emits a ſulphureous ſmell when heated, and is alſo entirely volatiliſed by heat; is not readily ſoluble in diluted nitric acid.

SPEC. IV.

NATIVE CINNABAR. MERCURY MINERALISED BY SULPHUR.

Fr. *Cinnabre natif ou oxyde de mercure ſulfuré rouge.*

Germ. *Zinnober.*

Cronſtedt. *Mercurius ſulphuré mineralitus.*

In this ſtate the mercury is found more generally, and in greater quantities than in the metallic ſtate.

Its component parts, the mercury and ſulphur, may be diſcovered by mixing it with iron filings, and expoſing it afterwards in a cloſe earthen diſtilling veſſel or retort, to a ſufficient heat; by which means, the ſulphur leaves the mercury, and unites with the iron; the mercury not being fixed in fire, is then ſeparated in the ſtate of very minute particles or vapours, which on cooling reunite, and collect in the receiver in the ſtate of perfect running mercury, and the ſulphur united with the iron, forming pyrites, remains in the retort. Inſtead

Inſtead of the iron filings, pure lime (or quick lime) is often employed in the proportion of one third of lime to one part of the ore, which occaſions a decompoſition on the ſame principle as the iron.

Thoſe two ways are choſen for obtaining the mercury from this ore.

The cinnabar is not ſoluble in nitric acid; when pure, it is entirely volatile in a cloſe ſubliming veſſel.

It exhibits different ſhades of red, as ſcarlet, cochineal, deep ruby colour, often lead grey. The deeper kind exhibits a lighter colour when ſcraped with a knife.

It is generally more or leſs ſhining; of various texture, as lamellated, fibrous, granular, earthy, and often alſo compact.

Its ſpecific gravity is generally $\doteq$ 7000. It can eaſily be ſcraped with a knife, and the ſofter kind ſtains the fingers red. Its variety of colour is derived moſtly from the different proportion of the component parts, and from the different degrees of heat, to which it muſt have been expoſed. So we find (though rarely) the mercury in the ſtate merely mixed with the ſulphur, exhibiting a greyiſh black powder, called *Æthiops mineral*, near *Kirchheim*, in *Naſſau*, and *Idria*, accompanied by lamellated cinnabar, and in Deux-Ponts, upon ſulphur pyrites; it has not been chemically combined by the aſſiſtance of heat, which is neceſſary for exhibiting the red colour.

The perfect combination of mercury and ſulphur or the CINNABAR, is found in compact maſſes—in radiated pieces—in maſſes compoſed of ſcales—in grains, and alſo cryſtalliſed: In three and four ſided pyramids; in three ſided priſms with three ſided pyramids; in double four ſided pyramids joined at their baſſes; theſe are generally truncated at the points, which make them exhibit an octaedron. The cryſtalliſed kind is ſcarce, and is always more or leſs tranſparent, and generally of a deep colour.

The cinnabar yields moſtly about 80 per cent. mercury, and the reſt ſulphur.

The matrix is generally indurated clay; white and ferruginous quartz; calcareous ſpar; argillaceous ſhiſtus; ſometimes heavy ſpar and pyrites.

It is found near Chilopan, in New Spain; near Nertſchinſk, in Siberia; Joachimſthal, in Bohemia; at Almaden, in Spain; on Monte Niſo, in Sicily; in the Dutchy of Deux Ponts; in Tranſylvania; at Siegelſberg and Schemnitz, in Lower Hungary; at Wolfſtein and Mörsfeld,

Mörsfeld, in the Lower Palatinate in Germany.

Sometimes the mercury, united with fulphur, is found mixed with iron, and alfo with other heterogeneous fubftances, which gives it a different appearance and quality—hence the following fpecies.

SPEC. V.

MERCURY MINERALISED BY SULPHUR, AND MIXED WITH OXYD OF IRON, OR FERRUGINOUS CLAY.

Hepatic Mercury.

Germ. *Queckfilber-Lebererz.*

The iron in this ore, may be afcertained by expofing a little of the powdered ore in a flat earthen veffel to a fufficient heat, fo as to volatilife the fulphur, and alfo the mercury preventing the fulphur to fufe and to combine with the iron, which is then left behind, and which may be diffolved in muriatic acid, and precipitated by pruffiate of alcali, or phlogisticated alcali.

There are two kinds of this ſpecies.

VAR. I. *Compact Hepatic Mercury.*

Its colour is the intermediate betwixt deep blackiſh—lead grey and cochineal red. Sometimes greeniſh and variegated.

It has a compact texture. It is ſhining, and takes a poliſh. It can be cut with a knife, and gives a cochineal red trace upon the *touchſtone.*

The other kind.

VAR. 2. *Shiſtous Hepatic Mercury.*

This kind exhibits chiefly the different ſhades of cochineal red. It is alſo a little ſhining.—It has generally a curved lamellated texture.

There is another kind which may be placed here, and which has a nodulous appearance, and is called in German *Korallenerz.*

Theſe mentioned varieties are found at Idria, and yield generally 50 or 60 per cent. of mercury; the reſt ſulphur and ferruginous clay.

SPEC. VI.

MERCURY AND COPPER MINERALISED BY SULPHUR.

Cronft. *Mercurius cupro fulphurato mineralifatus.*

CUPREOUS MERCURY.

This ore is either blackifh or greyifh. It is compact, brittle, and heavy; and has a vitreous appearance when frefh broken; it decrepitates in fire, and melts with borax before the blow-pipe in a green glafs.

The copper in this ore may be afcertained by digefting the refiduum, left, after the pulverifed ore is torrefied, and the fulphur and mercury feparated, with volatile alcali, which diffolves the copper in a blue colour.

It is found in the mines which produce cubical cinnabar, near Mofchellandfberg.

Its matrix is lapis ollaris—quartz and gangues of fhiftus.

SPEC. VII.

MERCURY COMBINED WITH HEPAR OF SULPHUR.

Cinnabar Alcalin of Born.

This ſpecies was firſt noticed by BORN. It was found in Idria. It has a fine red colour, is more or leſs tranſparent, and has a ſpatous form. When broken, the fragments are rhomboidal; when rubbed, it emits a ſmell of hepar of ſulphur, or *alcaline ſulphur*.

It is found in white calcareous ſpar.

SPEC. VIII.

MERCURY COMBINED WITH BITUMEN.

BITUMINOUS MERCURY ORE.

Fr. *Mercure bitumineux.*

Gmel. *Mercurius foetens.*

Its colour is dark brown; it has an earthy texture; it burns with a flame when kindled, and the vapours have the ſmell of bitumen.

It

It yields from 15 to 20 per cent. mercury.
It is found at Idria.

SPEC. IX.

MERCURY OXYDATED AND UNITED WITH MURIATIC ACID, AND A LITTLE SULPHURIC ACID.

CORNEOUS MERCURY. NATIVE SUBLIMATE.

Germ. *Natürlicher Sublimat.*

This kind is found of different colours:—ſmoak, aſh and yellowiſh grey, yellowiſh white, lemon-yellow and greeniſh.

It is found in ſmall cubes—in four ſided pyramids, in four and ſix ſided priſms.

The cryſtals have a pearl luſtre, they are ſemitranſparent, and ſoft. When thrown upon red hot charcoal, they diſcover a ſmell like garlic. When mixed with lime water, they occaſion a precipitate of an orange colour.

It yields 70 per cent. mercury.

It was found in the cavities, and on the ſurface of indurated martial clay, in certain mines of Deux-Ponts.

SPEC. X.

MERCURY MIXED WITH SILVER, IRON, AND COBALT, MINERALISED BY ARSENIC AND SULPHUR.

MERCURIUS MISTUS, *Monnet Syſtem Miner.*

Germ. *Vermiſchtes Queckſilbererz.*

It was found in the mines of Dauphiny, in the ſtate of white lumps. By analyſis 100 parts yielded 1 part mercury, $\frac{1}{3}$ ſilver, and the reſt was iron, cobalt, arſenic, and ſulphur.

The arſenic and ſulphur in this ore are eaſily diſcoverable by the ſmell, when the ore is heated in an open veſſel; the mercury diſtills over when the ore is expoſed to a ſufficient heat in a retort. The remaining iron—ſilver and cobalt may be further ſeparated by diſſolving the reſiduum in nitric acid, and ſeparating, firſt, the ſilver by marine acid in the ſtate of luna cornua—then the iron by phoſphoric acid, and the remaining cobalt by an alcali.

DIVISION

DIVISION II.

IMPERFECT METALS;

Or metals alſo malleable, but more or leſs deſtructable or vitrifiable in fire.

GENUS V.

IRON.

FERRUM.

Germ.	*Eiſen.*	Dan.	*Jernet.*
Fr.	*Fer.*	Hung.	*Vas.*
Ital.	*Ferro.*	Span.	*Yerro.*
Swed.	*Jeren.*		

Of all the metals, there is no one which is ſo copiouſly and ſo variouſly diſtributed through the Earth, or which anſwers ſo many purpoſes, either for ornament or uſe, in common life, as iron.

The great utility of this metal ariſes, partly, from certain qualities which are peculiar to it, partly from other qualities, which it poſſeſſes in in a more eminent degree than the reſt of the metals; and, laſtly, from its great abundance.

If we take a view of it in all its different ſtates, and the many uſes to which, in each of theſe, it is applied, we may pronounce it to be one of the moſt important products of nature. Its various uſes are not confined to it merely as a metal: though in this ſtate it is fitted not only for the groſſeſt purpoſes in mechanical and œconomical machinery, but for other purpoſes which are the niceſt and moſt delicate, as we ſee in the inſtruments of anatomiſts, engravers, &c. for which the other metals, from their inferior hardneſs, cannot be employed. Though in is metallic ſtate, we ſee it capable of being impregnated with that peculiar and ſtill inexplicable property, which we call the magnetic power, thereby forming that important inſtrument, which has opened worlds of glory, induſtry, and wealth to nations—*The Compaſs.* Yet in its non-metallic ſtate, are its uſes many and valuable.

Thus, for inſtance, united with vitriolic acid, or in the ſaline ſtate called martial vitriol, it affords, with the aſtringent principle of galls, that univerſally known and uſeful black liquid, by means of which we are enabled to preſerve the collected ideas of ancient time, and to communicate

communicate theſe and our own to each other, at any diſtance.

In another ſaline ſtate, that is mixed with the Pruſſic acid, it produces the beautiful blue colour, called Pruſſian blue.

In the ſtate of calx or oxyd, what a variety of colours does it not produce for glaſs and oil painting?

Almoſt all the common coloured ſtones and earths, gems or jewels, owe their different colours moſtly to the calx of this metal, according to its different ſtates and proportions.

In ſhort, there is hardly any colour, which is not, or which might not, be exhibited by this metal, in one or other of its different ſtates.

To this general praiſe of iron, we may add its worth as a medicine, which time and experience have now eſtabliſhed to be very valuable in many diſeaſes.

There are philoſophers who have ſuggeſted the idea, that iron is a production from organiſed bodies; from this it muſt follow, that it is of a later origin than the primitive rocks, ſuch as granit. But this notion is not well founded, as the mica, which is conſidered as one of the principle component parts of granit, contains iron in a conſiderable proportion, and very

very frequently feldſpar is ferruginous. Primitive ſhiſtus alſo, which very lately has been ſuggeſted to be of a prior origin to primordial granit, contains a certain portion of iron.

Though iron is found in all parts of the Earth, yet nature has divided it unequally, as to its quantity and different ſtates; hence it is found in ſome places in greater abundance than in others. England, Sweden, Germany, Ruſſia, &c. produce the greateſt quantity.

We find iron naturally in its metallic ſtate, though very ſcarcely; more frequently it is mineraliſed by ſulphur; ſometimes united with acids, but moſt generally we find it in the ſtate of calx or *oxyd*.

When iron is in its perfect metallic ſtate, it is of a livid whitiſh grey colour, ſomewhat inclining to blueiſh grey; it has a fibrous, a lamellated, or a granular texture, according to its different ſtate; it is lighter than gold, platina, ſilver, copper, lead, &c. Its ſpecific gravity is = 7,800.

It is the hardeſt of all metals, and when united with a due portion of plumbago, it becomes ſo hard as to ſtrike fire with quartz or flint.

It is brittle when fuſed, becomes malleable by repeated glowing and hammering, and acquires

quires a high degree of hardneſs by ſudden cooling; it is very refractory in fire, and requires 1620 degrees of heat, (Fahrent. ſcale) to melt; when perfectly fuſed, and gradually ſuffered to cool, it exhibits octoedral figures on its ſurface. Its tenacity is very conſiderable, it can be ſtretched out into very thin wire, as is ſeen by the thinneſt ſtrings uſed for harpſichords. It is attracted by the magnet, and is the only ſubſtance which acquires the magnetic power; a bar of iron becomes magnetic when kept for a long time in an erect poſition, or in the direction between north and ſouth; or when two pieces of iron are rubbed for a long time, in the ſame direction; or when ſtruck by lightning, as has been obſerved.

It does not readily combine with mercury.

It is eaſily acted upon by the atmoſphere, leſs by water, but it decompoſes the latter when perfectly red hot, and brought into contact with it, by which it abſorbs the one component part of the water, and acquires the ſtate of calx, ſeparating the other component part, the hydrogen, in the ſtate of inflammable air.

Iron has a ſtrong affinity to the baſis of pure air or *oxygen*, which explains why it is generally

rally found in the ſtate combined with that principle; and the various colours which iron in that ſtate reflects, ariſe probably from the different proportion in which it is united with it. The more it has combined with that principle, the more it loſes the property of being attracted by the magnet. It has a ſtronger affinity to oxygen than ſilver and copper, becauſe it recovers thoſe metals when in the ſtate of calces, by depriving them of the oxygen.

The great quantity of copper thus recovered from the cement water at Arklow, in the county of Wicklow, in Ireland, and at Angleſey, in Wales, give very ſtriking inſtances of ſuch operation.

Iron has an affinity to ſulphur, and when combined with it, it is called pyrites, in which ſtate, the ſulphur is prepared to abſorb oxygen, and to become an acid, when in contact with water. If this mixture abſorbs the oxygen from the ſurrounding air, a great quantity of heat is ſet free at the ſame time, which occaſions the mixture often to break out in fire. When ſulphur has abſorbed a ſufficient quantity of the oxygen, and is thus become an acid, it re-acts upon the iron, and ſometimes at the ſame time, upon the clay, and compoſes both martial vitriol and alum.

Iron is ſoluble in moſt acids, in which ſtate, it can be eaſily diſcovered when ſaturated, on adding a ſmall portion of what is called pruſſiate of alcali, formerly phlogiſticated alcali, with which it produces a blue precipitate, called Pruſſian blue, and with the aſtringent principle it makes ink.

Saturated with vitriolic acid, and cryſtalliſed, it exhibits rhomboid cryſtals of a pale green colour, which do not deliqueſce by expoſure to the atmoſphere, and which are not ſoluble in ſpirits of wine.

With muriatic acid it is ſoluble in all ſtates, and the cryſtals formed by evaporation, are yellowiſh green, deliqueſce eaſily in the atmoſphere, and are ſoluble in ſpirits of wine. The calx of iron, when melted with borax before the blow-pipe, produces a browniſh green glaſs.

Iron is volatiliſed by ſal ammoniac, or muriate of ammonia. The moſt general matrix of the iron ores, is clay.

DIVISION I.

Metallic iron, or ores of iron, nearly in the metallic ſtate, attractable by the magnet, and tranſmitting the electric fluid.

SPEC. I.

NATIVE IRON.

FERRUM NATIVUM.

Germ. *Gediegen eisen.*

Fr. *Fer natif.*

Many mineralogiſts ſtill doubt the exiſtence of native iron, without being able to give any reaſon againſt the poſſibility. From repeated and well ſupported accounts, there remains hardly any doubt, that the ſpecimens in Mr. Margraaf's collection of ores, which had been found near Eibenſtock in Saxony, were real native iron; they were found incloſed in a matrix of brown iron ſtone, in the ſtate of ſmall pieces, flexible, perfectly malleable, and fuſible *per ſe*, in fire; their colour was the medium between ſilver and ſteel grey; other ſpecimens had a ramified and ſpongy appearance, diſcovering no regular ſhape.

At *Kamſdorf*, in the territories of *Neuſtadt*, there has been found a piece of two pounds weight, which is preſerved in the cabinet there,

there, as a great curiofity. The cellular mafs of iron of 1600 pounds weight, mentioned by Mr. Pallas, found on the river Denifei, near Krafnojarfk in Siberia, and the other mafs of 300 pounds, found on Parana in Paraguay, feem to be coated with a natural varnifh, which has prevented the furface being oxydated, or rendered in the ftate of calx. The fpecimens poffefs all marks and qualities of metallic iron. Specimens of native iron have alfo been found in Iceland, and in Africa, on the river Senegal.

SPEC. II.

BLACK METALLIC IRON-STONE.

This ore contains the iron united to a fmall portion of oxygen.

Its colour is greyifh black, fometimes refembling the appearance of fteel; it is compact and fhining in its fracture, feldom ductile, generally more or lefs pulverifible, the powder appears black; it is attractable by the magnet, not quite foluble in vitriolic acid; it is fometimes found in grains, generally amorphous; it contains from 60 to 80 per cent. of iron. It is found in the iron mines of Swéden, at Taber in Smoland, at Bitzberg in Hungary, Transylvania. Its matrix is generally granitous, magnesian, or argillaceous, rocks, and sometimes white marble, often accompanied by shörl, garnits, and quartz.

SPEC. III.

OCTAHEDRAL IRON ORE.

Cronst. *Minera ferri calciformis inaurata octaedra.*

Waller. *Ferrum mineralisatum crystallisatum.*

This ore has the form of octahedrons, which are isolated and dispersed in a gangue of argillaceous shistus, or calcareous stones, as in the marble of Carara; in steatitical stones, and in ferruginous sand. The crystals are grey, or greyish black, very regular in their form, and of different size, generally strongly attached to the matrix.

They are reducible to powder, and moveable by the magnet.

They are found in Corsica and Sweden.

To

To this kind belongs the *native martial æthiops*, which is found in the ſtate of black, greyiſh, or brown powder, which is attractable by the magnet, and difficultly ſoluble in acids.

SPEC. IV.

EMERY.

Waller. *Firrum Smiris.*
Fr. *Emeril.* Ital. *Smeriglio.*
Germ. *Smirgel.*

This ſtone is exceedingly hard, ſo as to cut all ſtones except the diamond.

It is attracted by the magnet; its ſpecific gravity varies, generally = 3922.

Its colour is greyiſh black, when reduced to powder, the powder appears reddiſh grey; it has a granular texture; it contains from 20 to 30 parts of iron per cent.

It breaks with lapis ollaris, and quartz, blende, and often with magnetic iron-ſtone.

It is found in South America, at Guernſey, in white ſteatite.

There is another kind of ferruginous ſtone, alſo called emery, but which is not ſo hard, and the iron which it contains, is not attracted by the magnet; its matrix approaches the nature of tripoli.

The MANACANITE-SAND deſcribed by Mr. Gregor and me, in Crell's Journals, which contains a great portion of iron, and is attractable by the magnet, belongs alſo to theſe ſpecies. It is found in the ſtate of ſmall grains reſembling gunpowder.

It ſeems to contain a ſubſtance of a peculiar nature, as Mr. Gregor has firſt obſerved.

SPEC. V.

SPECULAR IRON ORE. MIROR ORE.

Gmel. *Ferrum ſpeculare.*

Cronſt. *Minera ferri calciformis indurata coerulenſcens.*

Fr. *Mine de fer ſpeculaire.*

Germ. *Eiſen glanz.*

This iron ore bears ſome reſemblance to the octahedral iron ore, but it has a finer luſtre and colour;

colour; in appearance it resembles steel, sometimes its surface is variegated, exhibiting the colours of the neck of a certain kind of pigeons. It is found as dodecahedrons, with triangular plains, truncated at two extremities—sometimes lenticular, or in double flat three sided pyramids, or cubical, but seldom of six sided plates, frequently in solid masses of an indetermined shape. It is hard, but pulverisable; it is slightly attracted by the magnet, but it transmits the electric fluid.

It contains generally from 60 to 70 per cent. iron.

It is found at the island Elba, also in Norway and Sweden.

SPEC. VI.

MICACEOUS IRON ORE.

Fr. *Mine de fer micaceé.*

Germ. *Eisenman.*—Werner. *Eisenglimmer.*

Ferrum ochraceum speculare micaceum.

Cronst. *Haematites caerulescens squamosus.*

Waller. *Ferrum mineralisatum, minera micacea squamosa colore griseo seu ferreonitens.*

 It

It has a fine brilliant ſteel colour and luſtre; it is compoſed of thin laminæ like mica, has generally little reddiſh ſpots from the hæmatites, which adheres or accompanies it; it contains more oxygen, and is therefore little moved by the magnet; it is brittle. Sometimes it is found exhibiting ſix ſided plates.

It is found near Suhl, in *Henneberg*; in Lower Hungary, Sweden, Dauphiné, and Auvergne in France.

SPEC. VII.

NATIVE MAGNET, or LOADSTONE.

FERRUM MAGNES.

Fr. *Aimant natif ou mine de fer magnetique.*

Waller. *Ferrum mineraliſatum, minera ferrum attrahente et polos mundi oſtendente.*

Ital. *Calamita.*

Lapis nauticus,—minera ferri attractoria & retractoria.

This iron ore attracts metallic iron.

Its ſpecif. gravity is = 4,243.

It

It contains often above 70 per cent. iron. Its colour is generally iron black. It is very hard, and difficult to pulverise.

It is moſtly found in Norway, Sweden, *Dannemark*, Lapponia, Siberia, Peru, Hungary, Bohemia, and at Johanngeorgenſtadt, and Ehrenfriederſdorf in Saxony.

Mr. Werner mentions three varieties :

VAR. 1. COMMON MAGNETIC IRON-STONE.

Germ. *Gemeiner magnetiſcher Eiſenſtein.*

Ferrum magnes vulgaris.

It is of an iron black colour ; it has a granular texture ; it is found in ſolid maſſes, or in ſmall particles diſperſed, and ſometimes in double four ſided pyramids—in ſix ſided flat priſms—cubical, and more or leſs ſhining ;—when broken, it reſembles metallic iron.

It contains from 50 to 80 per cent. iron.

VAR. 2. LAMELLATED or FOLIATED MAGNETIC IRON-STONE.

Ferrum magnes lamelloſum.

Germ. *Blättriger magnetiſcher Eiſenſtein.*

It

Its colour is iron black; it is found ſolid, ſhining, and has a lamellar texture.

It is found in Norway—Ruſſia—Siberia—India—Mexico.

VAR. 3. FIBROUS MAGNETIC IRON-STONE.

Germ. *Faſriger magnetiſcher Eiſenſtein.*

Its colour is ſteel or greyiſh black; it is ſolid or compact, and has a fibrous texture, and is found in Sweden.

VAR. 4. MAGNETIC IRON SAND.

Ferrum magnes glarcoſum.

Germ. *Magnetiſcher Eiſen Sand.*

Waller. *Ferrum mineraliſatum in formam arenae collectum.*

Its colour is deep iron black, a little glittering; internally ſhining—it has a conchoidal texture, and is found generally of octahedral bodies. It contains often half its weight of iron.

Its ſpecif. gravity is = 4,600.

It is found near Spandou in Germany, and in Virginia.

DIVISION

DIVISION II.

Ores of iron more or leſs oxydated, or in the calciform ſtate; not attractible by the magnet, and not tranſmitting the electric fluid; not fuſible per ſe*—they generally efferveſce with acids, but are hardly acted upon by nitric acid. They exhibit different colours according to the degree of oxydation or colcination, and the quantity of fixed air or carbonic acid which they are combined with; when expoſed to heat, they obtain a deeper colour, and approach to the ſtate to be attracted by the magnet; they are ſoluble in muriatic or marine acid, and the ſolution inclines more to yellow. The ores muſt be recovered by heat and charcoal, during which they yield a great quantity of fixed air, ariſing from the combination of the charcoal with the oxygen of the ore. They ſeem to originate from the other metallic iron ores, which have decompoſed the pure air or the water, or from the depoſition of martial vitriolic waters; or from the mutual decompoſition and attraction of carbonate of lime (or calcareous earth containing fixed air) and martial vitriol, by which operation the iron attracts the fixed air, and the vitriolic acid having a ſtronger affinity*

affinity to the lime, combines with it, and composes selenite. These calces or oxyds are seldom pure, they are frequently mixed with earth and stones, as lime-stone, clay, sand, &c.

The iron is in this state more frequently found than in any other state.

The following nine species differ from each other by colour, coherency, texture, shape, and proportion of iron.

A. *Red calces, or oxyds of iron.*

SPEC. VIII.

RED IRON GLIMMER.

Ferrum ochraceum rubrum inguinans.

Fr. *Mine de fer micacée rougeatre.*

Germ. *Kother Eisenrahm.*

It is found of different shades of the cherry red colour; it is composed of small shining scaly particles; it stains the fingers; is rather greasy to the touch, and astringent to the taste. It is found in compact masses, and sometimes covering other stones; it changes in time into micaceous

micaceous iron ſtone, and in hard, red, and compact iron ſtone.

It is found at Ehrenfriederſdorf, in the Erzgebürge, and in various other places.

SPEC. IX.

RED CALCIFORM OR OXYDATED IRON-STONE.

Germ. *Okkriger rother Eiſenſtein*, or *rother Eiſen-okker*.

It is found of a variety of ſhades of red; it is found compact and ſometimes very friable; has an earthy texture, no luſtre; it is ſoft to the touch, and ſtains the fingers. It generally accompanies the next following iron ſtones.

SPEC. X.

COMPACT RED IRON-STONE.

Ferrum ochraceum rubrum denſum.

Its colour is ſteel grey and cherry red; its texture is compact; it gives a blood-red trace upon

upon the touch-ſtone; it may be cut with a knife; it is found globular—kidney ſhaped—ſeldomer of regular figure, as cubical in four ſided pyramids, or as ſecondary cryſtal exhibiting ſix ſided pyramidical figures.

It is frequently found in Bohemia, and in different other places.

SPEC. XI.

COMPACT RED FIBROUS—HAEMATITES BLOOD-STONE, OR IRON STONE.

Fr. *Haematites.*

Ital. *Pietra de Sangue,* or *Ematita.*

Swed. *Blodſteen.*

Germ. *Blutſtein,* alſo *Rother Glaſkopf.*

Dan. *Straalig Rod Blodſteens malm.*

Cronſt. *Haematites ruber & nigreſcens flav.*

Its colour is generally the intermedium between ſteel grey, and blood red or cherry red.

It is found in ſolid irregular maſſes—kidney ſhaped—botrioid—tubular-cellular; it is a little ſhining—has a fibrous texture, breaks in cuneiform

form pieces; it gives a blood red trace; it contains generally from 40 to 50 per cent. iron, ſometimes 70.

It is found in many parts of the world; in Tranſylvania—Schneeberg—Carinthia—Bohemia—in England, near Durham—Workington, near Cambridge—in Glouceſterſhire and Cumberland—in Derbyſhire—in Scotland, near Aberdeen.

It is uſed in the art of burniſhing gold and ſilver; alſo, when ſoft enough, for drawing, and for poliſhing iron.

B. *Brown Iron-Stones.*

SPEC. XII.

BROWN IRON GLIMMER.

Germ. *Braun Eiſen glimmer—braun Eiſen rahm.*

Ferrum ochraceum brunum inguinans.

Its colour is generally the intermedium between tombac brown and ſteel grey; it is found frequently coating other iron ores; it is ſtrong glittering—ſcaly—greaſy to the *touch, and ſtains the fingers.*

SPEC.

SPEC. XIII.

EARTHY BROWN IRON-STONE.

Germ. *Okkriger brauner Eisenstein.*

Ferrum ochraceum brunum terrosum.

Its colour is brown inclining to yellow; it is found compact—friable and staining; it has an earthy texture without lustre.

It is generally found accompanying some of the next species of iron stones.

SPEC. XIV.

COMPACT BROWN IRON-STONE.

Germ. *Dichter Brauner Eisenstein.*

Ferrum ochraceum brunum densum.

Its colour is chocolate brown or yellowish, and tombac brown and blackish brown. It is found in solid masses—stalactitical—arborescent—pyramidical—as secondary crystals, sometimes coating other substances. It has a dull appearance,

appearance, ſeldom ſhining; it gives a yellowiſh brown trace; it accompanies often brown *glaſs kopf.*

It is found near Kamſdorf—near Suhl—near Gethlitz, and near Schleuſingen, &c.

SPEC. XV.

BROWN FIBROUS IRON-STONE, OR HAEMATITES.

Ferrum ochraceum brunum haematites.

Fr. *Hematite brune.*

Germ. *Brauner Glaſkopf.*

Its colour is deep brown or iron black, internally chocolate brown.

It is found of various ſhapes, like the red haematites; it is very ſhining, and has a fibrous texture. It breaks into cuneiform pieces;—it gives a yellowiſh grey trace;—it is ſometimes found covered with dentritical figures of manganeſe.

It is found in Kärnthen, near Eibenſtock—Schmalkalden and Könitz.

SPEC. XVI.

BLACK IRON-STONE.

Waller. *Ferrum haematites nigrescens.*

Germ. *Schwarzer eisenstein.*

Its colour is the medium between steel grey, and blueish black.

It is found solid, in kidney shaped pieces, botrioid or tuberculous; it becomes shining when rubbed; it has a conchoidal texture; it is brittle and hard.

It contains a little manganese. It is found frequently near Schneeberg.

There are other kinds of stones which contain iron in an oxyd or calx state, of the siliceous stones, such as the garnits, jasper, trapp; others of the magnesian genus, as serpentines; but these are mentioned already in the class of stones, in the first volume.

C. *Calcareous iron-stones.*

SPEC. XVII.

CALCAREOUS IRON-STONE. SPATOUS IRON-STONE.

Germ. *Spathiger eiſenſtein.*

Fr. *Mine de fer ſpatique.*

Dan. *Forenſpat ſtaalſtein.*

Swed. *Whït fermalm.*

Hung. *Spátos vas föld.*

Cronſt. *Terra calcarea marte intime mixta.*

This ſtone is yellowiſh, greyiſh white, brown, greeniſh grey, or cream yellow. It is found in ſolid maſſes, interſperſed in other ſtones, cellular, with cubical impreſſions, rhomboid, in ſaddle ſhaped cryſtals, in double four ſided pyramids; it is ſhining, ſometimes exhibiting a pearl luſtre, or a fat luſtre; it breaks in rhomboid pieces; it can be ſcraped with a knife; it effervеſces with nitric acid; its original colour is light, but becomes darker in time on expoſure to the atmoſphere; its ſpecific gravity is = 3,600, or 4,000,

H 2 By

By analyſis it yields oxyd of iron, manganeſe, carbonic acid, or fixed air, calcareous earth and water.

It is found near Freiberg, Kamſdorf, Könitz, Huttenberg in Corinthia.

In England there is a great quantity of ferruginous lime-ſtone found, which effervеſces with acids.

The ſtalactitical calcareous ſpar, when containing a little portion of iron, has been called flos ferri.

D. *Argillaceous iron-ſtones.*

Germ. *Thonartige eiſenſteine.*

Ferrum ochraceum argillaceum.

They do not efferveſce with acids.

SPEC. XVIII.

STALACTITICAL ARGILLACEOUS IRON-STONE.

Ferrum ochraceum argillaceum ſcapiforme.

Its colour is generally the medium between browniſh, blood red and cherry red.

It

It exhibits generally thin ſeparate ſtalks which are curved ; it has a fine earthy texture, is very brittle, gives a blood red trace, but ſtains verv little ; it adheres to the tongue, and is ſonorous when hollow.

It is found in Bohemia, and Bayreith.

SPEC. XIX.

LENTICULAR GRANULAR ARGILLACEOUS IRON-STONE.

Fr. *Mine de fer argilleuſe lenticulaire.*

Germ. *Linſenförmig körniger thonartiger eiſenſtein.*

Its colour is either reddiſh, browniſh, greeniſh black, &c.

It is very ſhining ; has a cloſe earthy texture, and is ſoft.

Sometimes it occurs in ſmall lenticular pieces.

It is found in Sweden in large quantity.

SPEC. XX.

BROWNISH RED ARGILLACEOUS IRON STONE.

Ochra ferri rubra.

Germ. *Röthel.*

Its colour is generally browniſh red. It is found compact, and ſlaty; and breaks or ſeparates into orbicular plates; it gives a blood red trace; does not ſoften eaſily in water; ſtains much, and is heavy.

It may be conſidered as a ferruginous argillaceous ſhiſtus.

SPEC. XXI.

COMMON ARGILLACEOUS IRON STONE.

Werner. *Ferrum ochraceum argillaceum vulgare.*

Germ. *Gemeiner thonartiger eiſenſtein.*

Its colour is various, yellowiſh, reddiſh, chocolate brown, and blackiſh brown.

It

It is found compact, as botrioid, cellular, generally containing or exhibiting conchoidal petrifactions.

It has a dull appearance, and a close earthy texture; and adheres to the tongue. It is found in Saxony, Upper Lusatia, in the county of Sussex, &c.

SPEC. XXII.

KIDNEY SHAPED, OR NODULAR IRON STONE.

Germ. *Eisen niere.*

Ferrum ochraceum argillaceum reniforme.

Its colour is yellowish brown; it is generally found in tuberculous masses; it has somewhat of a metallic lustre when broken, but the surface is dull.

It is found in Saxony and Poland.

SPEC. XXIII.

PISIFORM IRON-STONE.

Ferrum ochraceum argillaceum pisiforme.

Germ. *Bohnerz.*

Its colour is yellowiſh, reddiſh or blackiſh brown; its ſhape is nearly globular, or roundiſh; ſometimes it is found in the ſtate of ſmall kernels; it is compoſed of concentric curved coatings, reſembling *calculi.* It gives a light brown trace, and is ſoft enough to be ſcraped by a knife.

It is found in the principality of Heſſe, near Würtenberg, and in the Alſace.

When theſe ſtones are of a conſiderable hardneſs and magnitude, they are called rattelſtone, in German *klapperſtein*; lapis aetites, or eagle ſtone,—the latter name has ariſen from a notion formerly entertained, that eagles placed it in their neſts, to facilitate the laying of their eggs.

E. *Calciform ores of iron, probably originating from the depoſition of ferruginous waters, which has collected in ſwamps, or bogs, whence they are alſo called* BOGGY IRON ORE. *Certain authors ſuggeſt, that theſe iron ores originate from the decompoſition of animal and vegetable ſubſtances, which have been long under ſtagnant waters or bogs. They contain moſtly a ſmall portion of phoſphoric acid, and hence*

hence the iron obtained from theſe ores, is brittle, and is called COLD SHORT IRON. *Theſe ores do not effervеſce with acids, or at leaſt very ſeldom. They exhibit no regular ſhape.*

They yield ſometimes from 30 *to* 40 *per cent. iron.*

They generally form ſtrata, and are found in great abundance in the Highlands; in Provence in France, in Spain, and in Bohemia, where it is known by the name, *mine de fer limoneuſe.* In German, *raſeneiſenſtein.*

The following Species are denominated from the places or ſituation where they are found.

SPEC. XXIV.

MARSHY, OR SWAMPY IRON ORE.

Germ. *Moraſterz.*

Its colour is yellowiſh brown, ſeldom of a light ochre colour.

It is found compact and earthy; it is brittle and ſtaining.

It is found under moor grounds, or in bogs.

SPEC.

SPEC. XXV.

SUBAQUEOUS IRON ORE.

Germ. *Sumpferz.*

Wall. *Minera ferri ochracea ſubaquoſa.*

Ferrum ochraceum ceſpititium paludinare.

Its colour is deep yellowiſh, and blackiſh brown. It is found compact and ſolid, but generally perforated or ſpongy ; ſometimes in round balls, or roundiſh flat pieces ; it has a dull appearance, an earthy texture, gives a yellowiſh brown trace, and is rather ſoft.

It contains generally 30 parts of iron, and the reſt fixed air, phoſphoric acid, and volatile alcali, or ammonia.

It is found in brook waters, or ſtagnant lakes.

SPEC. XXVI.

WIESENERZ, by the German. (*Werner.*)

Ferrum ochraceum ceſpititium pratenſe.

Its

Its colour is deep black, or yellowiſh brown. It is found compact, generally ſpongy; it has a little luſtre, and a conchoidal earthy texture; it gives a yellowiſh brown trace. This kind is the richeſt of the bog ores.

SPEC. XXVII.

BLUE EARTHY IRON ORE. NATIVE PRUSSIAN BLUE.

Germ. *Matürliches berliner blau, or blaue eiſen erde.*

Fr. *Pruſſiate du fer natif.*

Lat. *Ferrum ochraceum cœruleum.*

Oxyd or calx of iron, united with pruſſic and phoſphoric acid, and argillaceous earth.

This ſubſtance never exhibits a regular ſhape, is always found in an earthy ſtate of a ſlight coherency; its colour is generally approaching to indigo blue, ſometimes the colour of ſmalte; it is very friable, not ſhining; it has a dull earthy appearance; it ſtains the fingers blue; it is light; when expoſed to heat,

heat, it burns, becoming browniſh red, and melts at laſt into a black ſlag; its colour is deſtroyed by alcalies and acids, but when the colour is taken away by the one, on adding the other, the colour always re-appears, in which it differs from the artificial Pruſſian blue. It is found in Siberia, in Schonen, in Saxony near Eckardſberg, and Weiſſenfels, in layers of clay and lime, alſo in ſwampy or boggy iron ores.

It has been found in the moors of Livonia, near Heidekendorf, in Ingermanland, and in the walls of the city of St. Peterſburg.

By analyſis it yields 25 per cent. of iron.

SPEC. XXVIII.

GREEN IRON EARTH. *(Diſcovered by Werner.)*

Ochra ferri viridis.

Fr. *Terre verte ou de verone.*

Germ. *Grüne eiſen erde.*

It is in an earthy friable ſtate, having a dull appearance; ſometimes compact, ſolid, or like a corroded ſtone. It is found of various ſhades of of the green colour, frequently pea green, and yellowiſh green; it is difficultly ſoluble in acids; its matrix is quartz, ſulphur pyrites, and clay.

It has been found in the mine *Neue Hoffnung Gottes*, at Braundorf, near Schneeberg; and in the mine Kalb, and Friſch Glück.

SPEC. XXIX.

ARSENICAL IRON ORE. MISPICKEL,
Or Speiſs of the Bohemians.

Its colour is generally ſteel grey, yellowiſh grey, &c. It has a metallic luſtre; it is found granular, in cuneiform, priſmatic, and rhomboidal pieces; is not magnetic; and is ſoluble in acids.

It is found in Spain, containing from 30 to 40 per cent iron.

SPEC. XXX.

BITUMINOUS IRON ORE.

Germ. *Eiſenbranderz, or Kohlen ähnliches eiſenerz.*
Fr. *Fer bitumineuſe.*
Wall. *Ferri minera carbonaria.*

Its

It is composed of calx of iron and bituminous matter; it burns and emits a bituminous smell, leaving a black coaly matter behind.

It resembles gagat coal; after burning, it is attractable by the magnet; it yields from 20 to 30 per cent. iron.

It is found in Saxony, &c.

DIVISION III.

Ores of iron in the state mineralised by sulphur, or sulphurated iron ores. They emit sulphureous vapours when torrefied; they are not soluble in marine acid; they have a metallic lustre, but a different colour from the metal. The colour is yellowish grey, paler than the copper pyrites.— When in contact with air and moisture, they decompose, produce heat, and the sulphur becomes an acid, which then re-acts upon the iron, and forms thus martial vitriol; when in contact with a clayey matrix, it forms also, and at the same time alum.

When the iron is to be extracted from these ores, the sulphur must be separated by a gentle heat possible to prevent the sulphur from becoming acidified, and charcoal is added to carry off the calcining principle from the iron.

SPEC.

SPEC. XXXI.

SULPHUR PYRITES—SULPHUREOUS MUNDIK.

Germ. *Schwefelkics.*

Fr. *Pyrite martiale.*

Ital. *Ferro pyritoſo.*

Hung. *Kovakö.*

Its colour is ſtraw yellow, with a metallic luſtre. It is found in ſolid maſſes—in ſmaller particles diſperſed in different matrixes, depoſited upon various ſtones, or of regular ſhape, as in cubes—as dodecahedrons—in double four ſided pyramids, or as icoſedrons with rhomboic faces; the alternate faces are ſtriated; it is harder than copper pyrites, and ſtrikes fire with ſteel.

It is found in various metalliferous mountains, and frequently in coal ſtrata and indurated clay.

SPEC.

SPEC. XXXII.

RADIATED PYRITES.

Germ. *Strahlkies.*

Ferrum mineralisatum pyrites radiatus.

Its colour is alſo ſtraw yellow; it is found in ſolid maſſes, as reniform—ſtalactitical—botrioid—with impreſſions of fluor—globular in dodecahedrons and cubes; leſs ſhining than the foregoing ſpecies; it has a radiated or fibrous texture, and is more brittle.

It is frequently found in Schneeberg and Freiberg.

SPEC. XXXIII.

HEPATIC PYRITES.

Germ. *Leberkies.*

Wall. *Pyrites fuſcus.*

Werner. *Ferrum mineraliſatum pyrites hepaticus.*

Its

Its colour is brown, ſteel—and yellowiſh brown. It has loſt its metallic luſtre by a ſlight degree of decompoſition.

It is found in ſolid maſſes, tubular, arboreſcent, cellular, ſtalactitical, globular, and with pyramidical and conical impreſſions, in ſix ſided plates, in cubes, as ſix ſided priſms, and ſix ſided pyramids.

It contains a little more iron than the foregoing ſpecies.

It is found frequently near Cremnitz in Hungary, and near Freiberg.

SPEC. XXXIV.

CAPILLARY PYRITES.

Germ. *Straalkies.*

Ferrum mineraliſatum pyrites Capillaris.

Its colour is deep cream yellow; it exhibits long capillary ſhining cryſtals, and is found near Schneeberg—Annaberg—Johanngeorgenſtadt, in the mine Adolphus, upon quartz, &c.

SPEC. XXXV.

MAGNETICAL PYRITES.

Germ. *Magnetischer Kies.*

Its colour is generally the intermedium between cream yellow and copper red. It is found solid, and dispersed in other stones; it is shining, and has a compact texture, is brittle, and is slightly attracted by the magnet.

Some mineralogists place plumbago amongst the iron ores, as it certainly contains iron; but I have described it amongst the inflammable substances in the first volume.

As to the manner of assaying iron ores, for the purpose of making a calculation of the quantity of metal which may be extracted from the ore; when to be wrought on a large scale, the following methods have been found to answer the purpose very accurately:

A certain quantity of the ore which is to be assayed, is first reduced to small particles, and torrified by a gentle heat, not stronger than is required to separate the moisture, and to volatilise the sulphur, if the ore contains any, which is easily perceived by the smell during the

the torrifaction. When the moiſture and ſulphur are ſeparated, four parts of the remaining ore is to be mixed with an equal quantity of common ſalt, or *muriate of ſoda (which has been previouſly deprived of the cryſtalliſing water, by ſtirring it in an earthen flat veſſel over fire)* and with the ſame quantity of a mixture of equal parts of fluor and pure lime, and half a part of charcoal. This mixture is kept red hot in a crucible covered with charcoal, for ¾ of an hour, after which the iron contained in that quantity of ore, is found in a metallic ſtate ſeparated in the bottom of the crucible.

Or in another way:

Four hundred grains of calcined borax, forty grains of ſlacked lime, and two hundred grains of the ore to be aſſayed, are mixed together. The mixture is pulveriſed, and placed in a lined crucible, which is to be covered. The heat of a forge furnace is then ſufficient to effect the reduction of the metal, which is generally done in the courſe of half an hour. This method Mr. Chaptal has alſo adopted.

In the moist or humid way:

This way of assaying the ores of iron, is attended with more difficulty. I found the following method the most simple one: A certain quantity of iron ore is reduced to powder, and digested with about six parts of marine acid, which takes up the iron, and such earths as are soluble in that acid, and leaves the silex and the sulphur behind; after which, the solution is to be saturated with potash, (or if the ore contains any copper, with volatile alcali or ammonia) which precipitates the iron in the state of *calx* or *oxyd*, along with the dissolved earths; the precipitate is then well dried, and strongly heated or calcined, after which, it is pulverised, and put in digestion with diluted nitric acid, which then takes up all the earths, together with the other heterogeneous substances, and leaves the iron behind, which, on account of its being so highly oxydated or calcined, loses its solubility in that acid; it is then well washed, freed from acid, and afterwards recovered by charcoal, or any other inflammable matter of that nature, which has a stronger affinity to the oxygen than the iron, and which carries the calcining principle off; the regulus thus found in the bottom of the

the crucible, in which the precipitate had been recovered by charcoal, indicates the proportion of the metal contained in a given quantity of the ore.

With regard to the procefs for working or treating iron ores, on a large fcale, attention muft be paid to the ftate and condition of the ore which is to be wrought, as well as to the nature of the heterogeneous fubftances which generally attend the ores, as iron is hardly ever found in its free or feparate ftate.

The chief fubftances or mineralifers by which the nature and ftate of iron is differently altered, and which are particularly to be confidered in the procefs of working the common and richeft iron ores, are fulphur, oxygen, *or the bafis of pure air*, carbonic acid, *or fixed air*; limeftone and clay are to be confidered as the general matrixes of the rich iron ores.

The principal object of the operator, in working the different iron ores, confifts, therefore, firft, in feparating the moifture and fulphur, or all that can be volatilifed by mere heat, by the procefs of torrifaction; for that purpofe, the ore is firft reduced to fmall pieces, and mixed with coals; the mixture is then raifed up in large flat heaps or beds, about two or three feet high, the outside or upper part is placed in a close manner, in order to prevent the accession of the pure air during the ignition and evaporation of the sulphur, &c.

The fuel is then kindled, and the moisture and sulphur gradually evaporate. After the sulphur is thus separated, the remaining ore is reduced to smaller pieces, and mixed with charcoal, or with coals freed from sulphur, and if the iron ore is mixed with clay, then burned limestone is also added; and if limestone is the matrix of the iron, then a certain portion of clay is to be added, in order to render the matrix more fusible, and to admit the metal to separate, which is recovered by the addition of charcoal, which separates the oxygen by uniting with it, and which, by the assistance of heat, is carried off in the state of carbonic acid or fixed air, whilst the metal on account of its superior specific gravity, subsides or sinks to the bottom of the furnace, and leaves the fused and scorified matrix floating on its surface in the smelting furnace. The heat in the furnaces is much increased by large bellows or blast works, which I have seen in great perfection at Mr. Wilkinson's iron-works in different places of England, who, by that contrivance, is capable of melting a larger quantity

quantity of iron ore, and alſo in a ſhorter time than in the uſual manner.

When the metal is found ſeparated from the ſlag, and running in the bottom of the furnace in a perfect fuſed and liquid ſtate, an opening is made in the ſide of the bottom, to let the metal run out, which by other contrivances, is conducted into forms, moulds, or caſts, which are to be filled with the metal.

The metal thus obtained is called pig iron, or caſt iron, which is brittle, and does not admit to be hammered or extended, but it can be rendered ſo, by heating and hammering; for this purpoſe, the pig iron is melted again in a different furnace, and frequently ſtirred while in the ſtate of fuſion; after which, it is carried to the forge hammer, or which is more convenient and advantageous, in making large bars of caſt iron, it is paſſed betwixt two large and heavy iron rollers, which Mr. Wilkinſon has very ingeniouſly invented, and by which means, large bars of iron can be conſiderably extended. I ſaw bars of iron of four feet long, and from four to five inches thick, paſſing in the courſe of five ſeconds through the rollers, and which were extended to twelve feet long, and proportionally flat; during which, the iron was at the ſame time freed

 from

from its impurities, like what takes place by hammering the heated caſt iron, but which is a much ſlower operation.

The thus ſlattened bars about two inches thick, are cut even by a large pair of ſciſſars directed by the power of the ſteam engine, which cuts it as a pair of common ſmall ſciſſars would cut a plate of lead. The flattened bars are then made to paſs betwixt another pair of iron rollers, by means of which, they are ſtill more flattened, and at the ſame time, cut into narrow and long thinner bars, in which ſtate, the iron is malleable and ready for ſale.

Caſt iron is brittle, and has a granular texture, which is changed into a fibrous, when rendered malleable.

All iron contains charcoal, and a certain portion of oxygen, which gives it its hardneſs, and without which, iron would be a ſoft metal. From the different proportion of theſe two ſubſtances depend the different qualities of iron, for we find that crude iron urged by a violent heat in a cloſe veſſel, affords the carbonic acid or fixed air, and paſſes to the ſtate of ſoft iron; the fixed air is thus compoſed, as the oxygen or the calcining principle unites with the carbone, and by aſſiſtance of heat, is brought into

the

the ſtate of gaz, which exhales and leaves the iron in a purer ſtate.

That kind of iron which contains an exceſs of carbone, may therefore be improved or meliorated by ſtirring it, while in the ſtate of fuſion, and while it is running out of the furnace; or it may be expoſed for a longer time to the action of the bellows or blaſt-work when melted, and the ſmalleſt quantity of charcoal made uſe of; but when the two before mentioned principles are mixed in a due proportion with the iron, the caſt iron requires only the action of heat, to bring it to its proper ſtate. When the calcining principle preponderates, the action of the bellows muſt be leſs applied, and the metal muſt be mixed or penetrated with a greater portion of charcoal, in order to carry off the ſuperabundant portion of oxygen.

Steel only differs from iron, as it contains a great portion of carbone, and hence ariſes its being unalterable in fire when expoſed to it in a veſſel excluded from the acceſſion of pure air; but when repeatedly heated, and expoſed to the atmoſphere, it returns to the ſtate of iron again.

Some iron is malleable when red hot, but is brittle when cold; ſuch iron melts eaſier than the malleable kind, and its being brittle, is probably

probably owing to a ſmall portion of phosphoric acid, as other iron melted with phosphate of iron, becomes evidently brittle.

The iron obtained from pyrites, is more readily ſoluble in acids, and more magnetic; it is malleable in white heat, and alſo when cold, but it is brittle when red hot.

Steel is harder than iron, more elaſtic, not eaſily acted upon by acids, and takes a higher poliſh. The brown iron ores, which contain a ſmall portion of mangancſe, are found to be the beſt for the proceſs of making ſteel. This proceſs is very ſimple;—bars of iron are placed in a ſtratified manner with charcoal, and expoſed to a white heat, after which, they are reduced to thinner plates, and hardened by putting them ſuddenly into cold water. Or 12 or 15 pieces of iron plates are ſoldered together, after being expoſed to a white heat; they are then hammered and extended again into bars, &c. In certain parts of Germany, it is done by cementation, that is, by placing iron in a ſtratified manner, with a mixture of 16 parts of lamp-black, 8 parts of charcoal, 8 of aſhes, and 5 of muriate of ſoda.

GENUS

GENUS VI.

COPPER.

CUPRUM.

Fr. *Cuivre.* Germ. *Kupfer.*

The alchemiſts diſtinguiſhed this metal by the name Venus, on account of the facility with which it unites with other metals.

Copper is not found either in ſo many parts of the earth, or in ſuch abundance as iron.

From the many purpoſes in common life to which it is applied, it is a very valuable metal; but it ſhould never be forgotten, that it is a poiſonous one, and hence more caution ſhould be uſed, than generally happens, in preparing culinary and pharmaceutical utenſils of it. From the ignorance or negligence of cooks and operators in pharmacy, concerning the nature of many vegetable and other ſubſtances which they boil, or otherwiſe prepare, in copper veſſels, much miſchief often enſues, both

both food and medicine being thereby rendered nauſeous, noxious, or poiſonous.

For other purpoſes, copper is very ſafe and uſeful, ſuch as for making diſtilling veſſels; for covering the bottoms of ſhips, and the roofs of houſes; for making braſs; bell metal; coins, &c.

Copper is found in different ſtates; in the metallic ſtate—in the ſtate of calx—mineraliſed by ſulphur and arſenic—and united with acids, or in the ſaline ſtate. It is alſo frequently found mixed with other metals. The mines of Siberia, of Cornwall, Angleſey, of Sweden, Lower Hungary, and Tuſcany, are the moſt productive. The matrix of the copper ores is generally indurated clay, quartz, and more rarely, limeſtone.

Copper, when pure, has a peculiar red colour, and a very compact texture, with a nauſeous taſte, and a diſagreeable ſmell on friction. Its ſpecific gravity is = 7,788.

It is very malleable and ductile; it is leſs hard and leſs elaſtic than iron; melts by a heat = to 4587, (Fahr. ſcale) and burns with a greeniſh flame; it detonates in a red hot crucible with nitre, and burns with a continued violent heat to a vitreous maſs. Expoſed to the atmoſphere, it is eaſily affected, and becomes

covered

covered with a greenifh coat; it is foluble in moft acids, and alfo in volatile alcali, or ammonia, and exhibits then a blue colour. With the fluoric acid, it produces blue cryftals, cubical and prifmatic; and with the arfenical acid, green cryftals. With the fulphuric acid, it produces blue rhomboic cryftals, called blue vitriol, ufed for black dyings, &c. With the marine acid, it alfo cryftallifes, but the cryftals deliquefce in the atmofphere. With the acetous acid, it makes verdigris. When in the ftate of folution in acids, it can be feparated from it in the metallic ftate, by a polifhed plate of iron. It unites difficultly with mercury, but adheres eafily to its furface; it has an affinity to, and combines with fulphur; it has a ftronger affinity to oxygen, or the calcining principle, than filver, and therefore feparates and recovers the filver, when in the ftate of calx, as in folution in acids. It unites almoft with all metals, and with many, very readily.

DIVISION I.

Copper in the metallic ftate, or poffeffing all properties of perfect metallic copper, free from fulphur, arfenic, and acids.

SPEC.

SPEC. I.

NATIVE COPPER. CUPRUM NATIVUM.

Germ. *Natürlich gewachſen, or gediegen-kupfer.*

Ital. *Rame nativo.*

Dan. *Naturlig kobberet.*

Fr. *Cuivre natif.*

Hung. *Termés rèz.*

This ſpecies of native copper poſſeſſes all the qualities of pure copper; it is however never found quite pure, but generally mixed with a ſmall portion of gold or ſilver.

It is found of an indeterminate figure, in ſolid and compact maſſes; as ſmall particles diſperſed in different ſtones; in lamellæ; in plates; arboreſcent; cubical, and in double four ſided pyramids; in oblong octahedrons.

Its ſpecific gravity is generally = 7,788.

It exhibits a bright luſtre when ſcraped with a knife, but appears generally tarniſhed, as blackiſh, browniſh, &c. tho' ſometimes with its natural colour. It is ſoft, flexible, malleable, and

and fuſible. It is frequently found diſſeminated in, or accompanied by brown or reddiſh iron ochre, which when hard and compact, is ſuſceptible of a poliſh, and exhibits then a metallic luſtre; or it is found mixed in red copper ore, and malachite.

Its chief matrix is calcareous ſpar, quartz, petroſilex, jaſper, and ſhiſtus. The copper in this ſtate, may be collected by the mere proceſs of fuſion, or ſmelting, after the matrix has been moſtly ſeparated.

It is found in very conſiderable quantities, in the Bannat of Hungary, Siberia, Tuſcany, Sweden, Cornwall, near Hudſon's Bay, and on the ſhore of the Copper Iſland, near Kamtſchatka, and alſo in Tranſylvania.

Copper is alſo found in the metallic ſtate, and obtained by the proceſs of precipitation, when the copper being diſſolved in vitriolic or ſulphuric acid, is brought into contact with iron, which deprives the copper of the calcining principle, and thus recovers it. This copper is called cement copper. A great quantity of copper is thus recovered by art, as at the copper mines at Arklow, in the county of Wicklow, in Ireland; and alſo near the Paris mountain, at Angleſey, in North Wales.

DIVISION

DIVISION II.

Native copper, more or less altered by the combination with the calcining principle or oxygen, and mixed with different other substances, as fixed air, oxyd or calx of iron, ferruginous clay, and exhibiting various colours. The species belonging to this division, contain no sulphur, or at least not in such a proportion as to be mineralised by it; they are all more or less brittle, and reducible to powder. They require charcoal to recover the metal by fusion, but no torrifaction. The copper is easily discovered by fusing a little with borax upon charcoal, by means of the blowpipe, or by dissolving a little of the powdered ore in sulphuric acid, in which the copper is discovered by means of a polished iron plate placed in the solution.

A. *Oxydated copper ores with scarcely any fixed air, not effervescing with acids.*

SPEC.

SPEC. II.

OXYD OF COPPER, OR COPPER COMBINED WITH THE CALCINING PRINCIPLE.

Werner. *Kupfer Ziegel erz.*

Lat. *Cuprum ochraceum lateritium.*

Fr. *Oxyde de cuivre.*

Cronſtedt. *Minera cupri calciformis pura rubra.*

Wallerius. *Cuprum corroſum & ſolutum e mineris cupri deſtructis, &c.*

Alſo called *Copper-malm.*

Mr. Werner notices two varieties of this kind of oxyd of copper, which differ from each other as to coherency and colour; and which he diſtinguiſhes by the name *Kupfer Ziegel erz,* which ſignifies copper ore of the colour of red bricks.

VAR. 1. RED OXYD, OR CALX—OF COPPER OF AN EARTHY APPEARANCE.

Wern. *Erdiges Kupfer Ziegererz.*

Cuprum ochraceum lateritium friabile.

It is of a hyacinth colour, or reddiſh brown. It is found in compact lumps, ſprinkled in the ſtate of ſmall particles—coating other copper ores. It is eaſily pulveriſable, and ſtains paper conſiderably.

VAR. 2. INDURATED OXYD OF COPPER.

Warn. *Verhärtetes Kupfer Ziegel erz.*

Cuprum ochrac. laterit. induratum.

Wallerius. *Minera cupri picea.*

Swed. *Pecherz.*

Its colour reſembles brown pitch, ſometimes the colour of hyacinths, or alſo ſteel grey and browniſh red.

It is found in various places: at Orrowizza, in the Bannats; at Kamſdorf, in Saxony. It ſeems to be a mixture of red copper ore, and brown iron ſtone.

It

It yields generally from 20 to 50 per cent. copper, and contains frequently a portion of ſilver.

To theſe varieties may be added the *Brown Copper ore*, or *Hepatic Copper*.

Germ. *Lebererz.* Fr. *Cuivee Hepatique.*

It is chiefly compoſed of oxyd of copper and iron, or of red vitreous copper mixed with oxyd of iron.

Its colour is brown; it is ſometimes in an earthy and friable ſtate, ſometimes compact and hard. It is occaſionally found ſtalactitical, has a ſhining texture, is met with in the Bannats in Hungary, and probably originates from copper pyrites.

It contains from 2 to 20 per cent. copper.

The BLACK COPPER; *Cuprum ochraceum fuliginoſum*, Cronſtedt. *Ochra cupri impura friabili ferro mixta*, ſeems to belong to the above ſpecies, and to be derived from the pyritical copper ore, which has undergone a certain change; its colour is generally browniſh black; it is found in a friable, or in a powdery ſtate, coating copper pyrites, or alſo in a compact ſtate, accompanied by malachites.—

It is found in Hungary—at Freiberg in Saxony; and Fahlum in Sweden.

B. *Red copper ores, or oxyd of copper, containing fixed air or carbonic acid. They effervesce with acids.*

SPEC. III.

RED, VITREOUS OR SHINING, COPPER ORE.

RED COPPER GLASS.

Germ. *Rothes Kupfer erz.*

Fr. *Chaux rouge de cuivre ou oxyde de cuivre rouge.*

Swed. *Red Kopper Malm.*

Dan. *Rod Kobberkalk.*

Hung. *Veres réz ásvány.*

Cronst. *Minera cupri calciformis pura & indurata colore rubro.*

Wallerius. *Cuprum minera solida, colore rubro, &c.*

This

This ſpecies of copper ore conſiſts of copper, fixed air, and a ſmall portion of oxygen. It is generally of a brown or browniſh red colour, and has ſometimes an earthy appearance; it is frequently mixed with other copper ores, as the green copper ore. It is found in ſmall longiſh cryſtals—has a fine texture, and reſembles cinnabar; when expoſed to a ſtrong heat, it becomes blackiſh. It contains frequently above 60 per cent. copper.

Its matrix is generally ferruginous clay; ſo it is found in the Bannats of Hungary,

The following three ſpecies ſeem to differ only by exhibiting a different texture, and by a different degree of coherency.

SPEC. IV.

COMPACT RED COPPER ORE.

Werner. *Dichtes rothes Kupfererz.*

Cuprum ochraceum rubrum denſum.

Its colour is generally the intermediate between lead grey and cochineal red. It is found

 ſolid—

ſolid—interſperſed of an indeterminate ſhape—perforated, and exhibiting a luſtre intermediate between vitreous and metallic.

It is not tranſparent, and gives a blood red trace when rubbed or ſcraped. It is generally accompanied by native copper, and contains often above 70 per cent. copper, and a great quantity of fixed air.

It is found in Cornwall—near Rhein Breitenbach in Colonia—Norway—and near Kamſdorf in Saxony.

SPEC. V.

LAMELLATED RED COPPER GLASS.

Germ. *Blättriges rothes Kupfer glaſſerz.*

Its colour is the intermediate between blood red and cochineal red; it is found in ſolid pieces, diſperſed through other ores, in reniform detached pieces, in double four ſided pyramids, in cubical cryſtals adhering to each other. It is ſtrongly ſhining; has a lamellated texture; gives a blood-red trace, and is brittle. Its matrix is generally ferruginous quartz.

It is found in Siberia—Hungary, &c.

SPEC.

SPEC. VI.

FIBROUS OR CAPILLARY RED COPPER GLASS.

Cuprum ochraceum rubrum plumoſum.

Its colour is crimſon red; it is found in the ſtate of capillary cryſtals, and called *Kupfer-blüte*, in ſmall flacky pieces. It is ſhining, and is found accompanied by brown iron ochre, malachite and native copper.

It is found in Siberia—Freiberg—Rheinbreitenbach, and in Hungary.

C. *Blue copper ores.*

SPEC. VII.

BLUE COPPER ORE, AZURE COPPER ORE.

Germ. *Kupfer laſur, Blau Kupfererz.*

Fr. *Mine de cuivre azurée, ou cuivre mineraliſé par l'acide aerien, petite portion d'air pur & d'eau & une grande quantite de matiére de la chaleur—chaux bleue de cúivre.*

Oxy—carbonate of copper.
Ital. *Rome lazzureo.*
Hung. *Lazur köves réz áſvány.*
Swed. *Koppar-lazur.*
Dan. *Blaae kobberkalk.*
Wallerius. *Cuprum lazureum.*

In this ſpecies of ore, the copper has combined with the calcining principle—with carbonic acid and water. It is ſoluble in nitric acid, and the ore requires only heat, and a ſmall portion of charcoal, to recover the metal.

This ſpecies appears in different ſtates, as to compactneſs and ſhape, which are deſcribed under the two following varieties.

VAR. 1. BLUE FRIABLE COPPER ORE.

Cuprum ochraceum azuleum friabile.

This kind has generally an earthy appearance: its colour is ſky-blue, or ſmalt-blue. It is generally found in a powdery ſtate, ſeldom compact; it ſtains a little; is found coating different ſtones, &c. and has yielded by analyſis, 69 parts of copper, 29 of carbonic acid, and 2 of water.

It

It is found in Poland, Saalfeld in Thuringia, and in Siberia.

Var. 2. Compact radiated, or fibrous azure copper ore.

Cuprum ochraceum azuleum radiatum ſolidum.

Its colour is generally ſmalt—blue, or azure blue. It is ſeldom found in large ſolid maſſes, but frequently in ſmall particles diſperſed through different ſtones—ſtalactitical—botrioid—often alſo exhibiting a regular figure, as flat rhomboic cryſtals, or the rhomboic octahedron—flat rhomboic tetrahedral priſms, terminating in dihedral ſummits—lenticular, &c. It is ſhining; has a radiated texture; leaves a ſky blue trace; is brittle, and efferveſces with acids.

It is found at Kamſdorf, in Tyrol, at Saalfeld, Zellerfeld, &c.

D. *Green copper ores.*

The following three ſpecies differ from each other, as to compactneſs, appearance of texture, &c. and differ from the foregoing blue copper ores, in the colour, and different proportion of component parts. They contain more carbonic acid, and leſs oxygen.

SPEC.

SPEC. VIII.

COMPACT MALACHIT.—GREEN COPPER ORE; COPPER COMBINED WITH CARBONIC ACID, WATER, AND A SMALL PORTION OF THE BASIS OF PURE AIR.

Fr. *Cuivre mineralisé par l'acide aerien, l'air pure & l'eau; ou mine de cuivre verte.*

Germ. *Grün kupfererz.*

Lat. *Cuprum ochraceum malachites.*

This ore generally exhibits a very fine grass green, emerald green, or apple green colour, sometimes approaching to the colour of verdigris.

It is found in solid masses of an indeterminate shape—in small particles interspersed with different matrixes, in kidney shaped pieces, or botrioid, composed of concentric layers—stalactitical. It has a silky lustre, and is hard enough to take a fine polish like marble. Its texture is generally fibrous or radiated; it effervesces strongly with acids, recovers before the blow-pipe, without any additional substance;

ſubſtance; and ſeems to be formed from a gradual depoſition of water, containing calx or oxyd of copper, in the manner ſtalactitical calcareous ſpar is formed. Its ſpecific gravity is generally = 3,641. It contains often from 60 to 70 per cent. copper.

The matrix is chiefly quartz.

It is found in Siberia, Hungary, and in Wales.

SPEC. IX.

SATTIN-LIKE GREEN COPPER ORE, OR RADIATED MALACHIT.

Lat. *Cuprum ochraceum malachites ſetaceus.*

Germ. *Sammt-erz.*

Fr. *Mine de cuivre ſoyeuſe.*

It is alſo frequently of a very fine emerald green colour, and is found in fibrous compact maſſes, or in ſmall particles diſperſed through, or depoſited upon various ſtones; but moſtly faſcicular, or in ſmall bundles compoſed of thin needle ſhaped cryſtals diſperſed in a radiated, or diverging manner.

The cryſtals have a ſilk luſtre. They efferveſce with acid.

It

It is found near Freiberg, Saalfeld, near Zellerfeld, and Lauterberg on the Harz, in Hungary and Tyrol.

SPEC. X.

MOUNTAIN GREEN COPPER ORE.

Lat. *Aerugo nativa? Chryſocolla.*
Fr. *Verd de montagne ou chaux de cuivre verte.*
Ital. *Verde di montagna.*
Swed. *Kopper grönt.*
Dan. *Gron kobberkalk.*

Its colour reſembles verdigris, ſometimes approaching to emerald green. It is found ſolid or in compact maſſes—in ſmall particles diſperſed in ſtones—or coating various ores; it has a dull appearance, very ſeldom any mark of luſtre; its texture is conchoidal; it is ſoft, and does not efferveſce with acids. It yields from 60 to 70 parts of copper, the reſt is chiefly oxygen, or the calcining principle.

It is found in Siberia, at Nertſchinſk.

SPEC.

SPEC. XI.

FERRUGINOUS GREEN COPPER ORE.

Cuprum ochraceum ferruginoſum.

The ferruginous copper ore is found in two different ſtates; as earthy, and in the ſtate reſembling flags.

The firſt kind is the earthy ferruginous copper ore.—*Cuprum ochraceum ferruginoſum terroſum.*

It has generally an olive green colour, and no luſtre, an earthy texture, and is very friable. It is found in compact lumps, and alſo frequently in the ſtate of ſmall particles diſperſed through various ſtones.

It is ſoluble in muriatic acid with effervescence, and the ſolution occaſions a blue precipitate with pruſſiate of potaſh, or phlogiſticated alcali, owing to the mixture of iron.

It is compoſed of copper, iron, oxygen, and carbonic acid.

It is found near Saalberg.

The other kind of ferruginous copper ore—*Cuprum ochraceum ferruginoſum ſcoriaceum*—exhibits

hibits generally a leek green colour, or the green colour of piſtachio nuts.

It is found ſolid and interſperſed in different ſtones; it is a little ſhining with a fat luſtre; has a conchoidal texture; no tranſparency, and is ſoft; it leaves an olive green trace on rubbing.

It is found near Kamſdorf, and Saalfeld.

SPEC. XII.

WHITE COPPER ORE. COPPER ALLOYED WITH IRON AND ARSENIC.

Germ. *Weiſs kupfer-erz.*

Gmel. *Cuprum albidum.*

Wallerius & Cronſt. *Cuprum ferro & arſenico ſulphure, &c. mineraliſatum.*

Fr. *Mine de cuivre blanche.*

Swed. *Weiſſerz.*

Hung. *Fejer réz áſvány.*

Its colour is the intermediate between ſilver and tin; it has a metallic luſtre, is compact, brittle, and when rubbed emits the ſmell of arſenic; it alſo ſtrikes fire with ſteel.

Its

Its component parts are copper, iron, and arfenic. It is feldom found but at Lorenz Gegentrum; near Freiberg, and Schneeberg.

DIVISION III.

Copper ores mineralifed by fulphur, not foluble in acid. They muft be torrified to feparate the fulphur, in order to collect the metal. They are eafily fufible by heat; emit a fulphureous fmell; when expofed to the blow-pipe, melt into a vitreous mafs, and are thereby eafily diftinguifhed from the other ores of copper.

SPEC. XIII.

VITREOUS COPPER ORE.

Cronftedt. *Cuprum fulphure mineralifatum.*
Fr. *Mine de cuivre vitreufe.*
Germ. *Kupfer-glafs, or glanz.*
Werner. *Cuprum nitidum.*
Swed. *Kopper glafs erz.*
Dan. *Kobber glas, or malm.*
Hung. *Uveg réz áfvány.*

Its colour is generally lead grey, purple and brown; ſometimes variegated; it has a metallic luſtre, and a conchoidal texture. When compact, its ſpecific gravity is = to 4, or 5,0c0.

It is ſoft enough to be cut with a knife; and melts eaſily before the blow-pipe.

It is found of regular ſhape, as in ſix ſided priſms accuminated with three faces; or in ſimple three ſided and four ſided pyramids.

It contains from 60 to 80 per cent. of copper, the reſt is chiefly ſulphur, and a ſmall portion of iron.

The matrix is chiefly limeſtone, quartz, and clay.

It is found in Bohemia, on the Harz, near Freiberg and Marienburg; alſo in Scotland, near Erſkine; in England, near Middleton Lyas; in Siberia, Norway, and Hungary.

SPEC. XIV.

COPPER PYRITES.—YELLOW COPPER ORE.

Cronſt. *Minera cupri pyritacea.*

Germ. *Kupferkies.*

Ital.

Ital. *Rame piritoso.*

Fr. *Mine jaune de cuivre.*

Swed. *Guhlkoppar malm.*

Hung. *Réz kova.*

This is the poorest, yet the most common of the copper ores; it contains a larger portion of iron than the foregoing species, and the copper is perfectly mineralised by sulphur.

Its colour resembles brass, sometimes approaching to the colour of gold. The deeper the colour, the richer in copper.

It is found in solid masses of an indeterminate shape, but also frequently of a regular one, as in simple three sided pyramids, in double four sided pyramids, in six sided plates.

It has a strong metallic lustre, and when broken, exhibits generally a conchoidal texture. Its specific gravity is = 4,160. It fuses easily, and is at last converted in a black slag. When moist and exposed to the atmosphere, it absorbs the acidifying principle from it, which is accelerated by the assistance of heat; the sulphur it contains, becomes thereby an acid, which is diluted by the moisture, and re-acts upon the copper, which it dissolves,

 and

and with which it forms a ſalt, namely, the ſulphate of copper, or vitriol of copper.

From this, the copper can be ſeparated and obtained in its metallic ſtate, by metallic iron. This proceſs is carried on, on a very large ſcale, in Wales, at the Paris mountain, and at Arklow, in the county of Wicklow, in Ireland; where the metallic ſalt, or cement water is partly found collected in the bottom of the mine, from the rain water diſſolving and waſhing down the ſalt.

At the Paris mountain, the miners ſeparate firſt the ſulphur, which they collect in a ſubliming apparatus, by heating a large quantity of the pyritical ore; after this, they lixiviate or waſh the remaining ore with water, which takes up the thus formed ſaline copper; the copper is afterwards ſeparated by iron plates, ſo as to be recovered by the iron, which deprives the copper of the oxygen, or acidifying principle.

The thus collected copper is called cement copper, which is afterwards edulcorated with water, gently dried and fuſed.

The ore which remained from the firſt lixiviation or waſhing, is then fuſed, and is, in that ſtate, ſent to Liverpool, where it is further refined.

Siberia,

Siberia, Hungary, and Sweden, produce a confiderable quantity of the pyritical copper ore. The matrix is frequently bituminous fhiftus, heavy fpar, and indurated clay; fometimes, petrofilex.

SPEC. XV.

VARIEGATED COPPER ORE.

Germ. *Bunt Kupfererz.*

Lat. *Cuprum mineralifatum variegatum.*

Peacocks tail copper ore.

Cuprum Pfittacinum.

This ore when frefh broken, appears copper red, or tombac brown, red tarnifhed, purple, azure blue, fky blue or green. It is fhining, and has a conchoidal texture; it yields from 40 to 60 per cent. copper; from 20 to 30 per cent. iron; and from 10 to 20 fulphur.

It is generally mixed with yellow copper pyrites, or vitreous copper ore.

It is found particularly fine in Siberia, alfo in the principality of Fauer.

It contains often a portion of ſilver; it ſeems to derive its variegated colour from the common copper pyrites, having parted with ſome of its ſulphur, *which has occaſioned the colour.*

SPEC. XVI.

GREY COPPER ORE.

Cronſtedt. *Pyrites cupri griſeus.*

Fr. *Mine de cuivre griſe.*

Germ. *Kupſer Fahlerz (Weiſſgülden* or *Harz.)*

Swed. *Fahl Koppererz.*

Dan. *Morkegraae,* or *grynig Kobbermalm.*

Hung. *Sárga réz áſvány.*

Wallerius. *Minera cupri griſea.*

This kind of ore is chiefly compoſed of copper, ſulphur, arſenic, and ſilver; ſometimes it contains alſo antimony, iron, lead, and ſilex. Its general colour is whitiſh grey, ſteel grey, lead grey, iron grey, and ſometimes variegated. It is found compact, either in lumps or in ſmall particles diſperſed in ſtones, and not unfrequently

unfrequently exhibiting a more or lefs regular fhape, as fimple three fided pyramids, fix fided prifms. It fhines with a luftre, is brittle and difficult to fufe *per fe*.

It yields fometimes from 20 to 60 per cent. copper; and is generally accompanied by yellow copper pyrites.

It has been analyfed; and the following fubftances were feparated:

16 parts copper, 34 lead, 16 antimony, 13 iron, 20 fulphur, 2 filver and 2 filex, in a hundred weight.

It is found in Siberia; Saxony; Sweden; Scotland near Erfkine; in Saxony, at Romfdorf and Freiberg; on the Harz; in Hungary; Tyrol, at Catharinaberg in Bohemia; at Köpnik in Tranfylvania; and alfo in Cornwall.

SPEC. XVII.

BITUMINOUS COPPER, OR INFLAMMABLE COPPER.

Cronft. *Minera cupri phlogiftica.*

Wallerius. *Cuprum mineralifatum materia bituminofa involutum facie carbonaria.*

Germ. *Kupferbranderz.*

Fr. *Cuivre melé avec matiére bitumineuse.*

This ore is chiefly a mixture of bituminous coal and oxyd of copper; it burns with a flame, and emits a bituminous ſmell.

It has never been found of a regular ſhape.

It is met with at Dalecarlie in Sweden; in gary; in the Elſaz; and Siberia.

SPEC. VIII.

ARGILLACEOUS COPPER ORE—SHISTOUS COPPER ORE.

Fr. *Cuivre avec ſulphur, fer, & d'argile.*

This ore ſeems to conſiſt of vitreous copper ore mixed with argillaceous ſhiſtus. Its colour is brown or blackiſh; it has a lamellar texture; is difficult to fuſe, except by the addition of lime-ſtone; and yields ſometimes from 6 to 10 per cent. of copper.

SPEC.

SPEC. XIX.

BELL METAL of RASPE.

This ore is compofed of fulphurated tin, copper, and iron.

It was found in Cornwall, near Whealrock, by Mr. Rafpe.

It is very fcarce.

DIVISION IV.

Copper combined with acids.

SPEC. XX.

COPPER COMBINED WITH MARINE ACID, OR MURIATE OF COPPER.

Fr. *Muriate de cuivre.*

Germ. *Salzfaures Kupfer.*

Its colour is greenifh; it is compofed of micaceous, quadrangular, fhining lamellæ, and is foluble in nitric acid. The copper is discovered by iron and ammonia, and the muriatic acid by a ſolution of ſilver in nitric acid. It contains generally a little clay; it has been brought from Peru in the ſtate mixed with ſand, by Mr. Dombey. I have never ſeen it; from experiments, I made to combine copper with muriatic acid, I found that the neutral ſalt always deliqueſced on expoſure to the atmoſphere.

SPEC. XXI.

COPPER COMBINED WITH SULPHURIC ACID, OR SULPHATE OF COPPER.

It originates from the decompoſition of the pyritical copper ore; and as it is a perfect ſaline ſubſtance, I have mentioned it already amongſt the metallic ſalts in the firſt volume.

SPEC. XXII.

COPPER COMBINED WITH THE ACID OF ARSENIC, ARSENIATE OF COPPER.

Germ. *Olivenerz*, or *arſenikal Kupfererz.*

It

It was analyſed by Klaproth.

It has a deep olive green colour, ſometimes the colour of emerald; it is found in the ſtate of needle ſhaped cryſtals—in oblong tetrahedral priſms; the cryſtals are tranſparent.

It is found at Carrarack, in Cornwall, in clifts of ferruginous and brittle quartz; alſo in Sileſia, near Jonobach.

To aſſay a ſulphureous copper ore, two drams, for inſtance, of the pulveriſed dry ore, are mixed with one dram of nitre, the mixture is thrown into an ignited crucible, and thus detonated, by means of which, moſt of the ſulphur is diſſipated; the remainder is kept on a ſtronger heat, until the reſt of the ſulphur is ſeparated. After this the maſs is ſtill more ſtrongly urged, until the ore enters into fuſion; a mixture of half an ounce of tartar, and one dram of common ſalt, and a ſmall portion of charcoal, is to be added in equal proportion.—When the effervefence, which takes place, has ceaſed, the crucible is to be covered, and a ſtronger heat applied for half an hour, to occaſion the copper to flow into a maſs; after which the metal contained in that quantity of ore, is found in the bottom of the crucible, adhering to the ſlag from which it is ſeparated by the hammer.

Or,

Or,

A certain quantity of the ſulphureous ore is previouſly freed from ſulphur, by a gentle torrifaction; the remainder is then weighed, and mixed with an equal portion of a mixture compoſed of 2 parts of pounded glaſs, 1 part of calcined borax, and 8 parts of charcoal, and fuſed; after which the metal is found in the bottom of the crucible.

To work the pyritical copper ores on a large ſcale, the ore is firſt picked or ſorted; afterwards it is reduced to ſmall pieces, and waſhed, to ſeparate the gangue and the other foreign lighter ſubſtances. It is then roaſted, to drive off the mineraliſer; after which it is fuſed in the blaſt furnace. The reſult of this proceſs is the black copper; which is again fuſed in the refining furnace, to diſſipate all the ſulphur. When it is very pure, it is poured into a broad veſſel or teſt; the ſurface is then cooled by throwing a little cold water on it, which occaſions it to ſeparate from the reſt. This is the copper in raſetles, which is then worked by the hammer. This is one of the general proceſſes of working the ſulphureous copper ores, which Mr. Chaptal has alſo mentioned.

The

The grey copper ore, or *Kupfer Tahlerz* of the Germans, which contains a portion of ſilver, is treated in the following manner: The ore is firſt torrified by a gentle heat, to ſeparate the ſulphur which is collected in cloſe veſſels; the remainder is fuſed *per ſe*, during which the earthy parts ſcorify, and the metal ſeparates in an imperfect ſtate; it is again torrified by a ſtronger heat in the open air, to ſeparate the remaining ſulphur, whereby the iron becomes ſcorified, and the copper and ſilver ſeparate in the ſtate of a black maſs; it is afterwards mixed with four parts of lead, fuſed and poured out into flat plates. Theſe plates are again placed upon iron plates, and covered with charcoal, and only ſuch heat is applied as will melt the lead; the lead, together with the ſilver, melts and runs from the plates, leaving the copper behind, which is then further recovered, and reduced to a perfect ſtate, by being fuſed with charcoal. The ſilver is afterwards freed from the lead, by the proceſs of cupellation.

GENUS

GENUS VII.

TIN.

STANNUM.

Germ.	*Zinn.*	Fr.	*Etain.*
Swed.	*Tenn.*	Ital.	*Stagno.*
Dan.	*Tinnet.*	Hung.	*Fejer ón.*

This metal is employed for various purpoſes, and therefore may be claſſed among the valuable ones.

It is uſed for covering the ſurface of copper veſſels, to prevent the copper from communicating its nauſeous and hurtful quality to food or medicine which is boiled in ſuch veſſels— it is uſed in the making of looking glaſſes— diſſolved in marine acid for callico printing— for coloured glaſſes—for enamel—when in the ſtate

ſtate of calx, for poliſhing purpoſes—and in medicine, againſt worms, &c.

Tin is found in very few parts of the world, in compariſon to moſt of the other metals.—Cornwall in England, and Bohemia in Germany, are almoſt the only parts where it has hitherto been found and wrought.

It is generally found in the ſtate of calx or oxyd, ſeldom with ſulphur.

It is the lighteſt of all the entire metals; its ſpecif. gravity is = 7,291.

It is a very ſoft metal, and requires leſs heat for fuſion than any other of the ſolid metals; melting by a heat = 410 of Fahr. ſcale. It is very flexible, and produces a crackling noiſe when bent; its colour is the intermediate between ſilver and lead; it is not eaſily affected by the atmoſphere, nor by pure water; combines very readily, and without the aſſiſtance of heat, with mercury, and alſo with ſulphur by fuſion.

It is ſoluble in ſulphuric, muriatic, and acetous acids, moſt readily in nitro-muriatic acid, forming a purple precipitate when mixed with a ſolution of gold; it is likewiſe ſoluble in nitric acid, but it ſeparates again in the ſtate of a white calx, owing to its having deprived the acid of its baſis.

The

The matrixes in which tin ores are found, are chiefly quartz, lithomarge, grey grit, indurated clay, and alſo ſome of the primitive and ſecondary rocks.

SPEC. I.

NATIVE TIN.

Stannum nativum.

Fr. *Etain natif.*

Germ. *Gediegen zinn.*

It is ſtill much doubted, whether the ſpecimens which are kept in a few collections of ores, are really native metallic tin. Mr. Quiſt, it is aſſerted, diſcovered a ſpecimen in Cornwall, in the year, 1766, which had a lamellar, and ſomething approaching to a regular form; it was embodied in quartz, accompanied by tin-ſpar. I ſaw a ſpecimen in Mr. Parkinſon's collection, which I examined and tried, and which was really metallic tin; but whether it was a product of nature, I cannot aſſert; it was a detached piece.

Mr.

Mr. Sage alſo poſſeſſed a ſpecimen of native tin.

SPEC. II.

NATIVE TIN-SPAR.

Waller. *Minera ſtanni ſpatoſa.*

Germ. *Weiſſer zinn-ſpath.*

Fr. *Mine d'etain blanche.*

This ore has been often confounded with tungſten. It has a milky white colour, ſemi-tranſparent, reſembling white heavy ſpar; it has a vitreous luſtre, and frequently a fibrous or lamellar texture. It is found of irregular ſhape, and alſo of pyramidical form, and in octohedrons.

When fuſed with borax, it produces a milk white glaſs. Its ſpecific gravity was found = 6,007. It has been found in Cornwall.

SPEC.

SPEC. III.

BROWN TIN-STONE, OR SPAR.

Germ. *Zinnſtein.*

Fr. *Etain vitreux ou oxyde d'etain.*

Hung. *Barriás or feketes üveg fejér on áſvány.*

By analyſis it has been found to conſiſt of calx of tin, calx of iron, and acid of tungſten. Its colour is generally brown, blackiſh, reddiſh brown, cream yellow. It is found in ſolid maſſes; when of conſiderable ſize, it is called in Germany, *zinngraupen*, and when in ſmall pieces, *zinnzwitter*.

It exhibits often a regular ſhape, as double four ſided pyramids—four ſided priſms, the angles of the pyramids are ſometimes truncated. The cryſtals are ſhining, and often ſemitranſparent, like pure brown colophony, and exhibit a conchoidal texture; it is alſo called reſin-like tin. Its ſurface can be ſcraped with a knife. Its ſpecific gravity is = 6,900. Sometimes it is ſo hard as to ſtrike fire with ſteel.

It

It contains from 70 to 80 per cent. of tin; that found in Cornwall contains frequently a ſmall portion of arſenic, which can be aſcertained by diſſolving it in marine acid, that depoſits the arſenic in the ſtate of a black powder.

Tin ores of this kind, are found in Cornwall, in Bohemia, at the *Schlaggenwalde* and *Zinnwald*; at Altenberg, in Saxony. The matrix is quartz—fluor—lithomarge—grey grit—and pyrites.

SPEC. IV.

STREAM TIN.——CORNISH TIN ORE.

Fr. *Etain limoneux.*

Stannum ochraceum cornubienſe.

Its colour is generally hair brown. It exhibits no regular ſhape, and is perfectly opaque. Its ſpecific gravity is = 6,450.

It is found in the ſtate of ſmall reniform pieces, rounded or approaching to the globular ſhape; ſometimes compoſed of concentric layers, and of a fibrous or radiated texture, reſembling the colour and appearance of a

 piece

piece of wood cut from a knotted tree, whence it is called wood-tin, in German, *holz-zinn*; but this kind is now very ſcarce.

This ſpecies of tin ore yields often above 60 per cent. of tin.

It is found only in Cornwall.

SPEC. V.

SULPHURISED TIN.——TIN PYRITES.

Germ. *Zinn-kieſs.*

Fr. *Etain ſulfureux.*

This ore was firſt aſcertained by Bergman.

It is eaſily diſtinguiſhed from the other ores of tin, by the ſulphureous ſmell which it emits when ſufficiently heated. It exhibits a ſteel grey colour, inclining to braſs yellow. It has a metallic luſtre, a fibrous or lamellated texture; ſometimes it exhibits the colours of the rainbow.

Its ſpecific gravity = 2,356. It is found in ſolid maſſes, and in the ſtate of ſmall particles diſperſed in copper pyrites. It has yielded by analyſis, 34 parts of tin, 30 of copper, 25 of ſulphur, and 3 of iron, beſides the matrix.

It

It is found in Silesia, near Gieren; and near St. Agnes, in Cornwall.

In order to assay a tin ore in the moist way, a certain quantity of it is pulverised, and put in digestion with six parts of concentrated sulphuric acid, for six hours; the liquid is then decanted, diluted with distilled water, and filtered, and afterwards precipitated by potash; if the ore contains any copper, it is to be precipitated by ammonia, which keeps the copper in solution. The precipitate is then sufficiently lixiviated, dried, and reduced by fusing it with charcoal.

To assay a tin ore in the dry way, frequently a mere fusion of the ore, surrounded by pounded charcoal, is sufficient to recover, and to collect the metal. Or a certain quantity of the ore is first freed from sulphur and arsenic, by torrefaction; after which, it is mixed with equal parts of potash, one half of common resin, and two parts of tartar, this mixture is fused in a crucible covered by charcoal, by means of which, the metal is recovered, and separated in the state of regulus.

In the working of tin ores, the ore with the matrix is first carefully sorted; after which, it is to be pulverised, and washed upon tables covered with cloth. By agitation with a stick or broom, the gangue is ſuſpended, or carried away by the water, and the tin ore remains alone.

The furnace made uſe of in Saxony, for the fuſion of tin ore, is a kind of blaſt furnace, on the hearth of which, is a groove to receive the metal, and convey it into a baſon; whence it is taken to be caſt, in moulds of copper, or of iron.

The tin ore of Cornwall is frequently mixed with copper, and arſenical pyrites; the quartz, which is the gangue, being very hard. The operation is begun by torrefaction of the ore, before it is pulveriſed. After the ore is waſhed, a ſeparation of the iron is effected by loadſtones, and the ore is uſually fuſed in the reverberatory furnace.

GENUS

GENUS VIII.

LEAD.

PLUMBUM. SATURNUS.

Germ. *Bley.* Fr. *Plomb.*

This metal is found in conſiderable quantity in many parts of the earth.

Its various uſes are ſufficiently known. It is the ſofteſt and leaſt tenacious of all metals; it is not ſonorous or elaſtic, but one of the heavieſt metals. Its ſpecific gravity is = 11,552.

Its colour is a blueiſh white, when freſh broken; it is malleable but brittle in a ſtrong cold; it is eaſily affected, and becomes ſoon tarniſhed in the atmoſphere; it may be eaſily cut with a knife, and ſtains the fingers blueiſh grey when rubbed; it fuſes eaſily by a heat = 540° of Fahrenheit's ſcale, and renders other more refractory metals, as silver, &c. more fusible; on this account, it is used for extracting silver from its matrix, or other ores, when in the metallic state; it becomes vitrified, *per se*, in a strong and continued heat, and vitrifies also other imperfect metals; hence it is used for the process of cupellation.

It is easily soluble in nitric and acetous acid, and the solution obtains a sweetish taste. It is precipitated from its state of solution in those acids, in the metallic state, by zink, on account of the stronger affinity which the zink has to the calcining principle. When prepared for calcination or oxydation, it unites in different proportions with the calcining principle or oxygen, and forms thus the massicot, when it exhibits a yellow colour—the minium, or red lead, &c. When in the state of calx, and united with carbonic acid, or fixed air, it makes the white lead. It combines very readily and without heat, with mercury, unites easily with sulphur, and is soluble in fat oils.

It is not readily soluble in sulphuric and muriatic acid, but has a stronger affinity to those acids, than to the nitric and acetous acids, and can therefore be separated from the latter, by the former, when in the state of solution.

Combined

Combined with acetous acid, it forms the ſugar of lead—with muriatic acid, &c. Turner's yellow.

It is uſed in the compoſition of flint glaſs.

The uſe of it for culinary and pharmaceutical utenſils, it is to be hoped, will be entirely aboliſhed, as well as the cuſtom of glazing the ſurface of earthen ware; much miſchief has been done by ſweetening wines with it, which had turned ſour. Fortunately, chemiſtry has provided us with accurate teſts, to diſcover ſuch pernicious adulterations.

It is found in nature in different ſtates, ſeldom, if at all, in the metallic ſtate—moſt generally united with ſulphur—ſometimes combined with carbonic acid—with ſulphuric acid—with phoſphoric acid.

DIVISION I.

Lead in the metallic ſtate.

SPEC. I.

NATIVE LEAD. PLUMBUM NATIVUM.

It has been, and is ſtill doubted, whether lead has ever been found in a perfect metallic ſtate; though it is ſaid to have found ſo in Poland, Sileſia, and near Karthen, and in Monmouthſhire. There is a ſpecimen kept in the late Dr. Hunter's collection, of native lead. Wallerius mentions three pieces of native lead. It has alſo been affirmed by ſome authors, that it has been found native in Villach, in Carinthia —in Vivarais—Poland, and Sileſia.

SPEC. II.

LEAD AMALGAM, OR LEAD COMBINED WITH MERCURY.

Lat. *Amalgama plumbi.*

DIVISION

DIVISION II.

Lead in the ſtate combined with the calcining principle or oxygen, ſoluble in nitric acid, eaſily pulveriſible, free from ſulphur, and recoverable by fuſion with charcoal, without a previous torrifaction, yielding fixed air on reduction. The following ſpecies belong to this diviſion; they differ from each other owing to the different ſubſtances with which they are mixed, and which occaſion their different appearances, as fixed air, iron, &c.

A. *Oxyds of lead, or calciform lead ores, not efferveſcing with nitric acid, almoſt free from fixed air.*

SPEC. III.

RED LEAD ORE, OR FERRUGINOUS OXYD OF LEAD.

Fr. *Oxyde de plombe rouge, or mine de plomb rouge.*

Lat. *Ochraceum plumbum rubrum nativum.*

Germ.

Germ. *Roth bley-erz.*

Cronſt. *Minera plumbi calciformis pura indurata rubra.*

Wallerius. *Plumbum ſulphure & arſenico mineraliſatum.*

Ital. *Spato di plombo roſſo.*

Swed. *Röd bly malm.*

Hung. *Veres ſpátos fekete on.*

Its colour is aurora red, reſembling red arſenic, or realgar. It is found in ſmall lumps of an indeterminate ſhape, alſo cryſtalliſed, exhibiting four ſided rhomboic priſms, terminating in three ſided pyramids; the angles of the priſms are from 62 and 118°. The cryſtals are ſhining, a little ſtriated on the ſurface; ſemitranſparent: They have a compact and even texture, and give an orange coloured trace.

By analyſis it has yielded = 36 parts of lead, 37 oxygen, 24 iron.

Its matrix is generally quartz, gneiſs, &c.

A certain kind has yielded on analyſis, lead, molybdenic acid, nickel, calcareous earth, iron, copper, cobalt, and ſilex.

It

It is found near Berefowfky, in the mines of Catharineburg in Siberia—and in Hungary.

B. *Oxyds of lead containing fixed air effervefcing with acids of an earthy appearance.*

SPEC. IV.

WHITE OPAQUE LEAD ORE, OR NATIVE WHITE LEAD.

Lat. *Ceruffa nativa.*

Its colour is generally white, fometimes yellowifh or greyifh, owing to a fmall mixture of iron. It does not exhibit a regular figure; it is very friable, and has an earthy appearance, and perfectly opaque; becomes red when expofed to a fufficient heat; effervefces with nitric acid, and yields fixable air or carbonic acid gas.

It contains generally from 60 to 80 per cent. lead.

It is found at Bleyberg.

C. *Oxyd,*

C. *Oxyd*, or *calxes of lead combined with fixable air, and of a ſparry or cryſtalliſed appearance.*

SPEC. V.

WHITE CARBONATE OF LEAD; WHITE TRANSPARENT LEAD ORE, OR WHITE LEAD SPAR.

Germ. *Weiſs Bleyerz.*

Lat. *Plumbum ochraceum album.*

Fr. *Mine de plomb blanc.*

Swed. *Hwit Bleymalm.*

Hung. *Fejer ſpatos fekete ón.*

Gmelin. *Plumbum ſpatoſum album.*

Cronſtedt. *Minera plumbi calciformis indurata alba.*

Waller. *Plumbum terreſtre vel lapideum, minera ſpatiformis alba & griſea.*

Its colour is whitiſh or colourleſs. It is found ſolid and in ſmall particles, diſperſed in, or depoſited upon ſtones of an indeterminate ſhape; ſometimes of a cellular appearance; alſo of of regular ſhape: in ſix ſided priſms, in four ſided priſms, and variouſly modified, frequently of the ſhape of rock cryſtal, ſometimes in needle ſhaped cryſtals of a ſilk luſtre, ſeldom in cubes.

The cryſtals are all ſhining, more or leſs tranſparent; have an even texture, ſometimes conchoidal, frequently a vitreous appearance. They effervеſce with nitric acid, and are ſoluble in it. They crackle when expoſed to heat, and recover *per ſe*, when expoſed in a cloſe veſſel to heat.

By analyſis, it has yielded 60 per cent. lead, 20 fixable air, 6 oxygen, and 3 of water.

Sometimes it is mixed with a little calcareous earth or clay; this admixture is generally found in the opaquer kind of white lead ore.

It is found near Freiberg—Marienberg—Zellerfeld—Tſchopace—in Siberia—Bohemia—Naſſovia—near Schemnitz, in Hungary—near Silvermine, in the county Tipperary, in Ireland—at the Lead-hills in Scotland—alſo in Somerſetſhire, generally in the cavities of decompoſed galena.

SPEC.

SPEC. VI.

BLACK LEAD SPAR.

Fr. *Mine de plomb noire.*

Germ. *Schwarzes Bleyerz.*

This ſpecies is found in the ſame ſtate and ſhape; it ſeems to differ from the foregoing ſpecies, only by its blackiſh colour, which probably has been occaſioned by ſulphureous vapours, which have tarniſhed the ſurface, or have more or leſs penetrated towards the internal parts of the cryſtals; it is found in the ſame places among the white lead ſpar.

SPEC. VII.

BLUE LEAD SPAR.

Germ. *Blau Bleyerz.*

This has generally the colour of Indigo blue or Pruſſian blue, ſometimes a lighter ſhade; it has its colour from copper and iron. It

It is found exhibiting ſix ſided priſms variouſly modified, and otherwiſe reſembles the foregoing ſpecies.

It is found at the Lead-hills in Scotland, formerly at the *Dreyfaltigkeit*, at Zſchopau.

SPEC. VIII.

GREEN LEAD SPAR.

Germ. *Grünes Bleyerz.*

Its colour is generally yellowiſh green; alſo the colour of verdigris. It is likewiſe found cryſtalliſed, and differs from the afore-mentioned ſpecies of lead ſpar, only in the modification produced by the colouring principle, as copper or iron. Its general ſhape is a truncated hexahedron.

It is equally eaſily reduced, as the white lead ſpar, by mere heat; and is alſo found on the Lead-hills.

SPEC.

SPEC. IX.

BROWN LEAD ORE.

Germ. *Braun Bleierz.*

Its colour is chocolate or reddifh brown; it is chiefly found in long four fided prifms, or in needle fhaped cryftals; the cryftals are femi-tranfparent.

It is found at Zfchopau; alfo in the County Tipperary, at the lead mines.

SPEC. X.

NATIVE GLASS OF LEAD.

Lat. *Vitrum Saturni nativum.*

Germ. *Natürlicher Bley glafs.*

Its colour is generally apple green. It is found compact, and exhibits a conchoidal texture when frefh broken; has a vitreous appearance, and is found near Zellerfeld on the Harz.

Sometimes

Sometimes it is found depoſited upon calcareous ſpar, reſembling ſilver like mica, ſuch as is met with at Bergmanſtroſt, near Andreaſberg.

SPEC. XI.

ANTIMONIAL LEAD ORE.

Germ. *Antimonialiſches Bleyerz.*

Cronſt. *Plumbum antimonio, & argento ſulphurato mineraliſatum.*

Wallerius. *Plumbum antimoniali mineraliſatum argento mixtum.*

Gmelin. *Plumbum ſtibiatum.*

This ore has a greyiſh or iron grey colour. It is compact, and has a ſtriated texture. It is chiefly compoſed of lead, ſilver, antimony, and ſulphur; and is found at Sahlberg, in Sweden; in Siberia; at Lautenthal on the Harz, and in Hungary.

DIVISION III.

Lead in the ſtate mineraliſed by ſulphur. It is diſcovered by its luſtre, and by its emitting a ſulphureous ſmell when torrified; the ores are not perfectly ſoluble in nitric acid, as the ſulphur is left behind. When nitric acid is poured on theſe ores, the acid becomes partly decompoſed, parting with ſome of its acidifying principle to the lead, and hence nitrous gas is produced. On ſeparating the lead from theſe ores, the ore muſt firſt be ſeparated from the ſulphur by torrifaction.

SPEC. XII.

GALENA, OR SULPHURATED LEAD ORE.

Germ. *Bleyglanz.*

Fr. . *Sulphure de Plomb.* alſo *galena.*

Cronſtedt. & Wallerius. *Plumbum ſulphure mineraliſatum.*

Ital. *Galena di Plombo.*

This

This is the moft common of the lead ores, and is found in many parts of the Earth.

It is generally mixed with fome other fubftance befides the lead and fulphur, containing often filver, fometimes iron and antimony.

Its colour is a deep lead grey, having a metallic luftre, the intermedium between lead and fteel; it may be cut with a knife.

Its fpecific gravity is generally = 7000.

It is found in folid maffes of an indeterminate fhape, alfo frequently exhibiting a regular figure as cubes—double four fided pyramids—four and fix fided prifms, and varioufly modified. Its texture is lamellar; it breaks generally in cubical pieces; it is alfo frequently met with in the ftate of fmall particles difperfed in, and fometimes depofited upon various ftones, frequently tarnifhed.

It contains often from 70 to 80 parts of lead, from 16 to 20 fulphur, and fometimes $\frac{2}{32}$ of filver.

Its matrix is generally heavy fpar—fluor—quartz—coals—fpatous iron ore—fhiftus and gneifs.

It is found at Bleyftedt in Bohemia; near Freiberg in Saxony; Siberia; at Sahlberg in Sweden, and in Derbyfhire; a certain kind of galena, which has a fteel luftre and texture,

 is

is called by the Germans, Bley-ſchweif Lead-rail.

Knitted galena has been found at the iſle Ilay, compoſed of rectangular four ſided priſms and plates, in all directions intermixed with white calcareous ſpar in grey lime-ſtone, which when longitudinally broken, exhibits a beautiful appearance.

SPEC. XIII.

PYRITICAL LEAD ORE.

Its colour is brown or yellowiſh brown; it exhibits often a ſtalactitical form; is very friable; has a ſtriated texture, and contains from 18 to 20 per cent. lead, the reſt being martial pyrites.

It effloreſces when long expoſed to air and moiſture, and affords ſulphate of lead.

SPEC.

SPEC. XIV.

GALENA COMBINED WITH PHOSPHORIC INFLAMMABLE AIR.

Called alſo *Slickenſide.*

It has the appearance and luſtre of galena; it is found in the lead mines of Derbyſhire, where the veins are cloſe together.

It produces a violent exploſion when ſuddenly broken, and when in contact with atmoſpheric air.

DIVISION IV.

Lead ores combined with acids.

SPEC. XV.

VITRIOLATED LEAD—SULFATE OF LEAD, OR LEAD COMBINED WITH VITRIOLIC ACID.

This ſeems to originate from the decompoſed pyritical lead ore.

It is generally found exhibiting octohedrons, ſometimes variouſly modified.

It is not ſoluble in nitric acid; its colour is yellowiſh brown, and the matrix chiefly ferruginous quartz and ſhiſtus.

It is found in Angleſey in Wales, moſtly in ferruginous ſtrata, above the pyritical copper ore; alſo near Strontian in Scotland.

It was firſt aſcertained and noticed by Dr. Withering.

SPEC. XVI.

PHOSPHORATED LEAD ORE, OR LEAD COMBINED WITH PHOSPHORIC ACID.

Germ. *Phoſphor ſoures Bleyerz,* or *grünes Bleyerz.*

Cronſt. *Minera plumbi calciformis pura indurata cryſtalliſata viridis.*

Waller. *Plumbum terreſtre vel lapideum minera ſpatiforme viridi.*

It was firſt aſcertained by Gahn and Mongés. It fuſes eaſily, and cryſtalliſes inſtantaneouſly in in dadecahedrons or polygon cryſtals, with a ſtriated ſurface ; is ſoluble in nitric acid, from which it is precipitable by ſulphuric acid.—Klaproth found it melt into a vitreous maſs when expoſed to the blow-pipe.

Its colour is generally green, or yellowiſh green, or olive green.

It is met with ſtalactitical, and alſo of regular ſhape, in ſix ſided priſms, and variouſly modified by truncations, ſometimes in ſmall perfect pyramids.

It is ſhining—ſemitranſparent, and gives a greeniſh trace.

It is chiefly compoſed of lead, from a phoſphoric acid, and is found near Freiberg—Zſchopau—Johanngeorgenſtadt—Zellerfeld—and on the Lead-hills in Scotland. A greyiſh and reddiſh kind is found at Huelgoet in Bretagne, and in Bohemia.

SPEC. XVII.

YELLOW LEAD ORE, OR LEAD COMBINED WITH ACID OF TUNGSTEN.

Gmelin. *Stannum flavum.*

Germ. *Gelbes bley-erz.*

 Its

Its colour is wax—lemon—yellow——or orange colour. It is found in ſolid pieces, ſometimes of a regular ſhape, in four and eight ſided plates, and variouſly modified by truncation, ſeldom in cubes. It has a lamellar texture, and is generally ſemitranſparent. Mr. HEYER found it containing the acid of tungſten, and Mr KLOPROTH the molybdenic acid. It is met with on Bleiberg in Corinthia—near Villach—near Zellerfeld, and in the Lead Hills in Scotland.

Yellow earthy lead ore is found near Tſchopau, and Freiberg; alſo in Siberia.

Grey earthy lead ore is alſo found near the Lead Hills, coating galena, and efferveſcing with acids.

In order to aſſay lead ores, different ways are made uſe of, according to the nature or compoſition of thoſe ores. When in the ſtate of calx, or combined with oxygen, it may be diſſolved in nitric acid, and precipitated from it in the metallic ſtate, by zink. If the ore contains ſilver, the ſolution is to be much diluted with diſtilled water, and the ſilver ſeparated firſt by marine acid; after which the lead may be precipitated either by zink, or by alcali.

Or in the dry way;

When in the ſtate of calx, it may be merely fuſed with charcoal, which ſeparates the oxygen, and ſets the lead free.

If the lead is combined with ſulphur, a certain quantity is reduced to powder, and put in digeſtion with nitric acid, which takes up the lead, and leaves the ſulphur behind; the lead may then be ſeparated from the acid, by alcali, the precipitate dried and weighed; 132 parts of the dry precipitate contains generally 100 parts of lead; or the lead may be ſeparated from the nitric acid, by muriatic acid, when the muriated lead is ſeparated in the ſtate of white cryſtalliſed particles, which when dried, contain generally 72 parts of lead in a hundred.

In the dry way, the ſulphurated lead ores, or galena, are firſt deprived of the ſulphur by torrifaction, and afterwards fuſed with 2 parts of black-flux, and ½ a part of iron filings, in a covered crucible, for half an hour; by this means, the iron takes up the remaining ſulphur; the alcali from the flux promotes the fuſion, and the carbone in the flux, carries off the oxygen; and thus the metal is recovered and obtained.

Near

Near the ſilver mines in the county of Tipperary, the lead ore, which is chiefly oxyd of lead combined with fixed air, is only fuſed with coal.

But in other places where the galena is wrought, the ore is firſt ſorted, to ſeparate the rich or pureſt ore from the vileſt parts, and the gangue which contains no metal. The ſorted ore is then reduced by hammering into ſmall parts, and the gangue ſeparated by waſhing and ſifting; after which, it is roaſted in a reverberatory furnace, with occaſional agitation, that it may preſent all its ſurfaces to the air; when the external part begins to aſſume the form of a paſte, it is covered with charcoal, the mixture is ſtirred, and the heat increaſed; the lead then runs on all ſides, and is collected at the bottom of the furnace, which is pierced, ſo as to permit the metal to flow into a receptacle properly defended by a lining of charcoal. The ſcoriæ which ſtill retain ſome lead, are fuſed by a blaſt furnace. The lead is caſt into pigs for ſale.

If the lead contains a conſiderable portion of ſilver, the ſilver is then obtained by cupellation.

GENUS

GENUS IX.

ZINC.

ZINCUM.

Germ. *Zink.* Ital. *Peltro.*

This metallic ſubſtance, which was firſt noticed by *Albertus Magnus* in the year 1280, and after him by *Henkel* and *Lawſon*, has generally been claſſed with the ſemi-metals, on account of its imperfect malleability. It admits to be extended into very thin and flexible plates, by the equal and gradual preſſure of the flattening mills, which Mr. *Sage* firſt obſerved, and it may therefore be conſidered as the intermediate ſubſtance between metals and ſemi-metals.

It is found in various parts of Europe; never, as far as I could aſcertain, in the perfect metallic

tallic ſtate, but generally in the ſtate of calx or oxydated—frequently alſo combined with iron and ſulphur—ſeldom in the ſaline ſtate, or combined with acids. When freed from heterogeneous ſubſtances, it has a whitiſh, inclining a little to blueiſh grey, appearance.

Its ſpecific gravity is = to 6,800.

It has a conſiderable hardneſs, and can only, with great difficulty, be reduced to ſmall particles by the hammer. Its texture is fibrous; it requires 700 degrees heat of Fahrenheit's ſcale to fuſe it; it has a bright luſtre when freſh broken, and retains its luſtre for a very long time in a pure atmoſphere.

It has a ſtrong affinity to oxygen, and deprives moſt metals of that calcining principle, and thus recovers them when they are in the ſtate diſſolved in acids, for which reaſon it is often uſed in chemiſtry as a precipitans; it is by this virtue of zink, as a component part of braſs, that pins become eaſily coated with tin. It combines readily with mercury, and without heat, and with ſulphur only, by means of iron. It burns with a beautiful blueiſh green flame, when it becomes red hot in a crucible, or when in very thin laminæ, and held in the flame of a candle.

It is ſoluble in nitric, ſulphuric, and muriatic acid, and produces by the two laſt hydrogen gas or inflammable air. It detonates with nitre when mixed and thrown into an ignited crucible. When fuſed with glaſs, it gives no colour to it; when expoſed to a ſtrong heat in a crucible, it is gradually converted into a white calx, which riſes a conſiderable diſtance out of the crucible, on account of its lightneſs. This calx, which is called flowers of zinc, is uſed internally as a medicine againſt certain diſorders, and alſo externally in ſurgery.

When neutraliſed by ſulphuric acid, it produces a white ſalt called vitriol of zinc, which is uſed particularly to remove inflammation of the eyes, &c.

DIVISION I.

Zinc in the metallic ſtate.

SPEC.

SPEC. I.

NATIVE ZINC.

Mr. Bomare mentions native zinc having been found in mines, where calamine is found in the Duchy of Limburg, and near Goſlar on the Harz, in the ſtate of ſmall pliant filaments; but, as I mentioned before, it is much doubted whether thoſe ſpecimens were originally native.

DIVISION II.

Zinc in the ſtate of calx or oxyd. It is very brittle, and eaſily reduced to powder, and the metal muſt be recovered by means of charcoal without torrifaction.

SPEC.

SPEC. II.

CALX OR OXYD OF ZINC. CALAMINE.

Lapis calaminaris.

Zincum calciforme.

Fr. *Chaux ou oxyde de Zink.*

Germ. *Galmey.*

Ital. *Calce de linco.*

Hung. *Kö-Tzin.*

Wallerius. *Zincum pulverulentum terreſtre.*

Cronſt. *Minera Zinci calciformis pura indurata.*

It ſeems to originate, as we learn from very inſtructive ſpecimens, from the ſulphuriſed zinc or blende, which has been deprived of the ſulphur by a gentle heat, after which the metal has combined with oxygen, and been thus brought into the ſtate of calx. The calx of zinc ſo formed, is always found mixed with more or leſs of ferruginous clay, and ſilex.—

It

It is met with in different degrees of hardneſs or coherency, and of various colours; ſometimes alſo of regular ſhape, or cryſtalliſed.

The following varieties are known:

VAR. I. COMMON OPAQUE CALAMINE, OR OXYD OF ZINC.

Werner. Germ. *Gemeiner Galmey.*

Its colour is yellowiſh grey and browniſh, alſo whitiſh grey; it has an earthy appearance; it is found in compact maſſes, cellular, ſtalactitical, perfectly opaque, and of different degrees of coherency. When digeſted with ſulphuric acid, it is moſtly diſſolved, emits heat, but occaſions hardly any efferveſcence; the acid takes up the metal and clay, and the ſilex is left behind. The iron which the ſolution contains, is diſcoverable by a little pruſſeate of potaſh, or phlogiſticated alcali.

It yields by analyſis: 84 parts of zinc, 0,3 iron, 12 ſilex, and 0,1 of argillaceous earth.

It is found in flötz mountains of lime or ſhiſtus, as near Bleyberg in Carinthia—in the mountain Stollberg in Sweden—near Beúthen in in Silefia—near Hohenhan in Saxony—Bohemia—Auftria—in Flintfhire and Somerfetfhire, and near Wirkefworth in England. A purer kind is found in New Spain between Chilapan and Troizlan—near Nertfchinfk in Siberia—near Olkufh in Poland—near Tornowiz in Silefia, &c.

It is ufed for the making of brafs.

VAR. 2. SPATOUS CALAMINE, OR SPATOUS CALCIFORM ZINC ORE.

Germ. *Spathiger galmey.*

Lat. *Zincum ochraceum calamina fpatofa.*

Its colour is yellowifh grey; it has a fpatous and lamellar texture; generally femitranfparent. It is frequently found of regular fhape: in rhomboid four fided prifms — rectangular fix fided plates—in three and fix fided pyramids. The cryftals have a luftre, generally accompanied by galena and brown oxyd of iron.

Sometimes it is found exhibiting two hollow fix fided pyramids, which feem to be an incruftation depofited upon calcareous fpar, and originating in this manner: The liquid fulphate, or vitriol of zinc, one of the component parts of the ſulphuriſed zinc ore, becomes, by the abſorption of oxygen, an acid, namely, the ſulphuric: this acid coming into contact with calcareous ſpar, unites with the earth of the ſpar, and the fixed air thereby diſengaged, combines with the oxyd of the zinc, and forms the incruſtation, which conſiſts chiefly of calx of zinc and fixed air.

The common cryſtalliſed calamine is found near Bleyberg in Carinthia—on the mountain Schwarzenberg—in Auſtria—at Nottingham, and in Somerſetſhire in England.

There is another kind of oxyd or calx of zinc found, which is chiefly compoſed of calx of zinc and ſiliceous earth, called by Gmelin *Zincum Siliceum.*

It has the appearance of zeolithes, with which it has been often confounded. When diſſolved in acid, it makes a galatinous maſs. It is white; its texture is fibrous, generally diverging or radiated. It is found as anincruſtation, or mammillated with a radiated texture; ſometimes of regular ſhape, as in ſmall thin cryſtals—in hexaedral flattened priſms, terminating by two facets.

Mr.

Mr. Pelletier found it containing, by analyſis, 36 parts of zinc, 50 of ſiliceous earth, and 12 water.

It has been found near Friburg, and near Wanlok-head in Scotland, where I met with very fine ſpecimens.

SPEC. III.

OXYD OR CALX OF ZINC, COMBINED WITH, OR MINERALISED BY FIXED AIR.

CARBONATE OF ZINC.

Vitreous zinc ore.

Fr. *Mine de zinc ſpathique.*

Germ. *Zink-ſpath.*

This ore is perfectly ſoluble in ſulphuric acid, without emitting heat. The fixed air is diſcovered by the effervеſcence, &c. which takes place when diſſolved in the ſulphuric acid, and the zinc combined with the acid, makes the vitriol, or ſulphate of zinc.

Its colour is generally greyiſh, inclining to blueiſh, greeniſh and yellowiſh, which ariſes from a ſmall portion of iron. It is found of various degrees of tranſparency. It is ſometimes ſo hard, as to emit ſparks when ſtruck with ſteel. When broken, it reſembles quartz; when expoſed to fire, it becomes yellow. It is found in ſolid maſſes, ſometimes in ſix ſided compreſſed priſms, both ends being covered by pentagons, frequently alſo as capillary cryſtals.

It contains chiefly 65 parts of zinc, 28 of fixed air, and 6 of water, ſometimes a little iron and ſiliceous earth.

It is found in Flintſhire and Somerſetſhire—in Carinthia—near Freiberg—that from Siberia has a mammillary appearance, and a fibrous texture.

DIVISION II.

Zinc and iron mineraliſed by ſulphur, or ſulphuriſed ores of zinc—emit a ſulphureous ſmell when torrified.

SPEC.

SPEC. IV.

BLENDE. (From the German language, in which it ſignifies blinding or deceitful.)

SULPHURISED ZINC.

In German alſo, *Geſchwefelter zink.*

Lat. *Zincum mineraliſatum blenda.*

Ital. *Zinco ſulfureo.*

From the reſemblance which it ſometimes bears to galena; it has alſo been called *Pſeudo-galena*; when of a blackiſh colour, it is called *Black-jack.*

Cronſt. *Zincum calciforme cum ferro ſulphuratum.*

It is found of various colours: brown, yellow, hyacinth, ſometimes reſembling chryſolith, or the colour of melted yellow wax.—Sometimes it exhibits a metallic luſtre. The ſulphur may be ſeparated by digeſting the pounded ore with ſulphuric acid, which takes up the zinc and iron.

It is found in various ſhapes and mixture; it has a lamellar texture, and the lamellae can be eaſily ſeparated, eaſier indeed than in the galena, from which it differs by its inferior ſpecific gravity, as well as by its loſing the luſtre when moiſtened, but which it recovers when dried again. When expoſed to ſufficient heat, it burns with a blueiſh flame, and frequently emits a phoſphoreſcent light when ſcraped with a knife in a dark place. When digeſted with ſulphuric acid, it emits hepatic air which may be explained; when the ſulphuric acid comes in contact with the ſulphur of the ore, it is deprived of a portion of oxygen which combines with the ſulphur, and conſequently a part of the ſulphur is ſet free—a portion of water is alſo decompoſed, and hence a quantity of hydrogen becomes free, which latter, aſſiſted by the heat which is likewiſe produced, occaſions it to take up a portion of ſulphur, and goes off in the ſtate of hepatic air. Some chemiſts ſuppoſe that the hepatic air was produced by the acid having acted upon the ſulphuriſed ore which contained lime, as it was frequently found in calcareous matrix. I have examined

many

many ſpecimens of blende, but never found calcareous earth a conſtituent part of it.

The phoſphoreſcent kind contains leſs iron.

By means of nitro muriatic acid, the metal may be extracted from the ore, and the ſulphur ſeparated. It is frequently found mixed with ſilver, copper, lead, and arſenic, alſo ſilex and clay. It is found detached, and alſo diſperſed or embodied in galena, and yellow copper ores. It is often found to be a good indicator of the veins of noble metals; in many ores it is hurtful, as it prevents the ſeparation of other metals from their mineraliſer. When mixed with lead, it is called *Tuttanego.* Its primitive figure ſeems to be the regular tetrahedron, which is variouſly modified by truncation, making it appear as octohedrons or hex-octohedrons.

The following varieties of blende are known:

Var. I. Yellow Blende.

Germ. *Gelbe Blende.*

Its colour varies a little, as deep brimſtone yellow, inclining to olive and aſparagus green, reddiſh brown, and aurora red.

It is found in ſolid maſſes, and alſo diſperſed in different matrixes, ſometimes cryſtalliſed; the cryſtals are generally embodied, and on that account it is difficult to aſcertain their perfect figure. They are ſtrongly ſhining, and have a parallel lamellated texture; the fragments indicate dodecahedrons, generally tranſparent; it leaves a light yellowiſh grey, almoſt greeniſh white trace; when rubbed, it diſcovers a ſulphureous ſmell, and a phoſphoreſcent light; it is almoſt ſoluble in nitric acid.

By analyſis, it yields = 64 zinc, 20 ſulphur, 05 iron, 04 fluoric acid, 01 ſiliceous earth, and 06 water.

Var. 2. Brown Blende.

Its colour is reddiſh and yellowiſh brown, ſometimes inclining to blackiſh, hyacinth red.

It is found ſolid and interſperſed, alſo of regular ſhape: in rectangular four ſided priſms, in octohedrical cryſtals, and variouſly modified by truncation. The outſide is brightly ſhining; when freſh broken, it exhibits a luſtre the intermediate of a vitreous and fat luſtre.—Its texture is lamellar; it is found opaque, and

alſo

alſo ſemi-tranſparent; it emits a ſulphureous ſmell on rubbing.

It has yielded by analyſis = 44 zinc, 17 ſulphur, 24 ſiliceous earth, 05 argillaceous earth, 03 water.

It is found near Freiberg, &c.

VAR. 3. BLACK-BLENDE. BLACK-JACK.

Germ. *Schwarze Blende.*

Its colour is dark and browniſh black, and ſometimes blood red on the points.

It is found ſolid, and alſo in ſmall particles depoſited upon ores of regular ſhape: in ſimple three ſided and double four ſided pyramids, variouſly modified. It has a luſtre; a lamellar texture, and is generally opaque. It gives a greyiſh and reddiſh brown trace, and a hyacinth red colour to nitric acid on digeſtion; it is generally accompanied by arſenical pyrites.

It yields by analyſis = 45 zinc, 29 ſulphur, 09 iron, 06 lead, 01 arſenic, c4 ſilex, 06 water.

It is met with near Freiberg—near Bleyberg in Carinthia—near Joachimſthal and Przibram in Bohemia—in Tranſylvania—near Sahlberg in in Sweden—near Scharffenberg in Saxony, and in Hungary, alſo in different parts of Wales, often accompanied by fluor.——A reddiſh blende is found near Königſberg in Lower Hungary; and near Freiberg. Greeniſh blende is found in Pacherſtollen, near Schemnitz in Lower Hungary.

DIVISION IV.

Zinc combined with acids, or in the ſaline ſtate, ſoluble in water.

SPEC. V.

SULPHATE OF ZINC. VITRIOL OF ZINC.

Zincum vitriolatum.

Germ. *Zink-vitriol.*

This ſpecies originates from blende, having become acidified by the abſorption of oxygen, and thus forming the ſulphuric acid, which has afterwards combined with the calx, and compoſed the ſulphate or vitriol of zinc.

It is found near Sahlberg in Sweden—near Cremnitz. When perfectly cryſtalliſed, its ſhape is a rhomboic priſm, terminating in four ſided pyramids. This operation in nature proceeds very ſlowly, and as the product has been found uſeful for many purpoſes, the operation is ſupplied by art on a large ſcale. Almoſt all the vitriol of zinc (in German called *Weiſſer Vitriol)* which is met with in commerce, is prepared as the Rammelſberg near Goſlar on the Harz: for which purpoſe, after having roaſted the galena which is mixed with blende, it is thrown, when ſtill ignited into ciſterns full of water, where it is left for 24 hours, which roaſting and extinguiſhing is repeated in the ſame water; after which the lixiviated ſaline liquor is ſtrained, evaporated, and put into coolers. At the end of 14 or 15 days, the liquid is decanted to ſeparate the cryſtals. The thus obtained cryſtalliſed maſſes, are melted in iron veſſels, and then poured into other coolers, where the whole is ſtirred until it becomes ſolid.

Braſs.

The manner of making braſs is generally done in the following way:

Equal

Equal parts of pounded and ſifted calamine, or calciform ores of zinc, and pounded charcoal are mixed, and a little moiſtened; it is then placed in a ſtratified manner, with the fourth part of its weight of copper, either in plates or in ſmall pieces, in a crucible which is to be covered; there are generally ſeveral of ſuch filled crucibles placed at the ſame time in a blaſt furnace upon an iron grate; and covered with coals. When in 12 or 14 hours, two coverings of coal have been conſumed, and that the large flames, which riſe out the opening, diminiſh, and appear with a clear blueiſh opaleſcent like colour; it is conſidered as a mark or indication of the mixture having undergone a perfect combination. The crucibles are then taken out, and the metal is put into another crucible previouſly ignited; when the metal is perfectly fuſed, it is poured out, and caſt into plates. This firſt ſmelting yields an impure braſs, and the ſcoriae which are ſeparated, contain ſtill a portion of the metal which is further ſeparated by another ſmelting with charcoal, calamine, and copper.

If the braſs is meant for caſting, a greater portion of calamine can be employed; but a leſs portion is neceſſary for braſs, which is to be worked by hammering.

DIVISION

DIVISION III.

OF

SEMI-METALS,

Not malleable, more or lefs brittle.

GENUS X.

BISMUTH.

BISMUTHUM.

Germ. *Wifmuth.*

Fr. *Bifmuth ou Etain de Glace.*

Swed. *Afkbly.*

This metallic fubftance was firft defcribed by Agricola, and by Schroeder in the year 1641.

It

It is not ſo frequently found as many other metals, and it ſerves for few uſeful purpoſes in common life. It is found in the earth in very few different ſtates, more generally native or in the metallic ſtate, than moſt of the other metals; ſometimes combined with ſulphur or arſenic; more ſeldom in the ſtate of calx, and never, as far as I know, in the ſaline ſtate.

When ſeparated from heterogeneous ſubſtances, its colour is ſilver white, inclining to reddiſh. It is brittle, and can be eaſily reduced to ſmall particles; it is ſoft enough to be cut with a knife; it has a lamellar texture; its ſpecific gravity is = 9,800. It requires leſs heat for fuſion than almoſt any other metal, melting by a heat = 460 degrees of Fahrenheit's ſcale; it is ſcarcely affected by the common atmoſphere, or by pure water. When long expoſed to the atmoſphere, it obtains a purple tarniſh. It can be volatiliſed by heat, and eſcapes in the ſtate of greyiſh white vapours; it combines readily with mercury and with ſulphur; when fuſed, it exhibits on cooling, cubical figures on the ſurface. It is ſoluble in ſulphuric, nitric, and marine acid, moſt readily in nitric acid, leſs and more difficult with ſulphuric and muriatic acid. When diſſolved in nitric acid, it is precipitable by a mere

mere dilution with pure water. The precipitate is white, and is uſed as a pigment by hair-dreſſers to blacken the light hairs, alſo as paint for the ſkin.

The ſolution in certain acids may be uſed for ſympathetic ink, as it becomes black when expoſed to heat. When fuſed with borax, it produces a brown vitreous maſs. It emits a blueiſh flame when burnt. When in the metallic ſtate, it is uſed for the compoſition of types, in letter founderies.

DIVISION I.

Biſmuth in the metallic ſtate, perfectly ſoluble in nitric acid.

SPEC.

SPEC. I.

NATIVE BISMUTH.

Bismuthum nativum.

Germ. *Gediegen Wismuth.*

Swed. *Gedieget Askbly.*

Hung. *Termes Vismut.*

Dan. *Naturlig Vismut.*

Its colour is silver white inclining to reddish, sometimes variegated on the surface. It differs from the purified and fused metal, by exhibiting a larger lamellar texture.

It is found in solid masses, and also in small particles dispersed in, and frequently deposited upon different stones, in the state of plumous striated lamellae. Its regular shape is, cubes, simple four sided plates, sometimes octohedron. It is generally accompanied by cobalt ores ; its matrix is red jasper, petrosilex, quartz, heavy spar, and cobalt ores.

It

It is met with at Schneeberg in Saxony—at Joachimsthal and Johanngeorgenstadt in Bohemia—in Dalecarlia in Sweden.

It is easily separated from its matrix by simple fusion, on account of its being easily fusible.

DIVISION II.

Bismuth in the state of calx or oxyd, having no lustre, being friable, of an earthy appearance, and emitting no sulphureous smell when ignited, but soluble in nitric acid.

SPEC. II.

NATIVE CALX, or OXYD of BISMUTH.

Bismuthum calciforme.

Germ. *Wismuth Kalk.*

Fr. *Chaux ou oxide de Bismuth.*

Dan. *Vismut-mulm.*

Hung. *Földe Vismut.*

Cronst. *Bismuthum calciforme pulverulentum.*

Its colour is yellowish grey, greenish, and straw-yellow grey.

It is found compact, and dispersed in, generally coating the surface of other bismutic ores. Sometimes in cubical pieces, and in small lamellæ. It has no lustre, but an earthy appearance or texture. The metal can be recovered by fusing it with charcoal. It is chiefly composed of bismuth, oxygen, and a small portion of fixed air. It is mostly accompanied by sulphurised and native bismuth.

It is found at Johanngeorgenstadt in Saxony —at Joachimsthal in Bohemia.

Its matrix is sometimes argillaceous shistus.

DIVISION III.

Bismuth mineralised by sulphur or arsenic; is not quite soluble in acids, and emits a sulphureous smell when ignited.

SPEC. III.

SULPHURISED BISMUTH.

Germ. and Swed. *Wismutglanz.*

Ital. *Bismuto sulfureo.*

Fr. *Mine de bismuth sulphureuse.*

Hung. *Asványos Vismut.*

Cronst. *Wismuthum sulphure mineralisatum.*

Its colour is lead grey and blueish grey—sometimes variegated.

It is found in ſmall particles, diſperſed in various ſtones, needle-ſhaped and capillary; ſometimes in lamellæ, forming ſmall cells; it has a luſtre; a radiated or lamellar texture; it ſtains a little, and may eaſily be cut with a knife; it does not efferveſce with acids; emits ſulphureous vapours when heated, and reſembles ſometimes galena or radiated antimonial ores.

The ſolution in nitric acid appears green;—it conſiſts chiefly of biſmuth and ſulphur.

It is found near Altenberg in Saxony—near Schneeberg in Sweden—near Chuteniz in Bohemia.

SPEC. IV.

MARTIAL SULPHURISED BISMUTH.

Cronſt. *Wiſmuthum ferro ſulphurato mineraliſatum.*

It has a yellowiſh grey appearance, reſembling ſomewhat martial pyrites, and a radiated texture.

It is found near Gillabek in Norway.

SPEC.

SPEC. V.

ARSENICATED BISMUTIC ORE.

Germ. *Arsenikalischer Wismuth.*

It is of a yellowish white colour, having a brilliant lustre; it is harder than native bismuth; it emits a garlic smell when ignited; it is generally covered by oxyd of bismuth.

It consists of bismuth, arsenic, and sulphur, and is found at Schneeberg, generally in ferruginous jasper, accompanied by cobalt ore.

GENUS XI.

NICKEL.

NICCOLUM.

Germ. *Nikkel.*

This metallic ſubſtance has only ſince the year, 1751, been aſcertained to be a peculiar metal, by Mr. CRONSTEDT, though the ſubſtance from which he extracted it, had been already known to HIERNE, in the year, 1694, and was afterwards more noticed by HENCKEL, who conſidered the ſubſtance as a compound of copper, cobalt, and arſenic. Mr. Bergman afterwards aſcertained more of its diſtinguiſhing properties.

This metallic ſubſtance is not found in great abundance, and as to its utility, very little has been aſcertained yet.

It

It is found in nature, generally in the metallic ſtate, more rarely in the ſtate of calx. When free from heterogeneous ſubſtances, it exhibits a reddiſh white, or the colour of fleſh; when freſh broken, it has a ſtrong luſtre; it has a fine grained compact texture; as to ductility, it admits a little to be flattened by hammering, ſimilar to caſt iron. Its ſpecific gravity is = 9000; it requires a very intenſe heat for fuſion and is fixed; it is not affected by pure water, but when for a long time it is expoſed to the atmoſphere, its ſurface becomes gradually altered, and covered with calx or oxyd of a greeniſh hue; this is ſooner obſerved when the metal is heated, and at the ſame time, in contact with the atmoſphere. When fuſed with borax, it produces a glaſs of a hyacinth colour. It is attracted by the magnet; this property was firſt aſcribed to iron, which was thought to be a conſtituent part of this metallic ſubſtance.

It is ſoluble in ſulphuric, nitric, and muriatic acid, moſt readily in nitric acid; the ſolution has a green colour; the cryſtals when ſaturated with nitric acid, and evaporated, exhibit rhomboidal cubes.

Volatile alcali or ammonia diſſolves it, and exhibits a blueiſh green colour. A piece of poliſhed iron put into a ſolution of this metal, does not occaſion a precipitate, by which we learn, that the blue colour does not originate from an admixture of copper.

The neutral ſalt formed with ſulphuric acid, alſo cryſtalliſes, but the cryſtals effloreſce on expoſure to air; with muriatic acid, the cryſtals have an emerald green colour, and exhibit oblong rhomboidal octahedrons. When mixed with ſilver by fuſion, it makes a white malleable mixture.

It is uſed by the Chineſe for the making of white copper, which they call *Packfong*.

DIVISION I.

Nickel in the metallic ſtate.

SPEC. I.

NATIVE NICKEL. KUPFERNICKEL.

Niccolum metallicum.

Cronſt. *Niccolum ferro & cobalto arſenicatis & ſulphuratis mineraliſatum.*

It

It was firſt diſcovered by Hierne, in the year 1694. Its colour is copper red, deeper than the purified metal.

It exhibits a conchoidal ſurface when broken, as to luſtre, it reſembles the hepatic martial pyrites ; it is more brittle than the pure metal; its ſpecific gravity is generally = 7807. Volatile alcali extracts a blueiſh colour from it, and acids, a green. When thrown upon red hot charcoal, it emits a ſulphureous and arſenical ſmell. It contains frequently iron—arſenic—cobalt, more ſeldom biſmuth or copper, and very ſeldom ſilver or gold.

Its matrix is calcareous ſpar, and heavy ſpar. It is found at Joachimſthal, in Bohemia—at Schneeberg, and Johanngeorgenſtadt, in Saxony—at Andreaſberg, on the Harz—near Dauphiny—on the Pyrenean mountains—at Triego, in Cornwall—in Thuringia—Saalfeld, in Sweden, and in Siberia. The metal is obtained from the ore, by torrifying the ore firſt, to ſeparate the arſenic or ſulphur, and the reſiduum is fuſed with three parts of black flux, and a little charcoal.

SPEC. II.

MARTIAL NICKEL.

Germ. *Gediegen eiſen nikkel.*

When freſh broken, it is yellow; it has a lamellated texture; when expoſed to air, ſoon turns blackiſh; when heated, it emits no arſenical or ſulphureous ſmell.

It is found ſometimes in thin rhomboidal plates, which are placed in an irregular manner, one over the other.

It is found along with red arſenic, in argillaceous ſhiſtus, at Joachimſthal, in Bohemia.

SPEC. III.

NATIVE CALX, OR OXYD OF NICKEL.

Germ. *Kupfernikkel okker.*

Ital. *Calce di nickel.*

Fr. *Fleurs de nickel.*

Swed. *Nickel-bloma.*

Dan. *Nikkelmulm.*

It

It ſeems to originate from the decompoſition of kupfernickel. It is the metal combined with oxygen, and a little fixed air. Its colour is a pale green, or blueiſh green; it has an earthy appearance, and is very friable; it is found coating kupfernickel; ſometimes interſperſed in the matrix, ſeldom in compreſſed ſhining filaments.

It is found at Joachimſthal, in Bohemia—at Koſemüz, in Sileſia—at Schneeberg, in Saxony.

Mr. Klaproth, and Heyer, found it mixed with ſiliceous, argillaceous, magneſian, and calcareous earth.

GENUS XII.

ANTIMONY.

ANTIMONIUM.

Fr. *Antimoine.* Germ. *Spiesglanz.*
Swed. *Spitsglas.* Hung. *Pisgoltz.*

This metallic substance was noticed by Basil Valentin.

It is found in various parts of the earth. It is a very useful substance, particularly in medicine; it is likewise used for different metallic compositions, and in letter founderies. It is found in nature in the metallic state—in the state of calx—mineralised by arsenic, but most generally with sulphur, called crude antimony.

It is generally met with in flötz mountains. When free from heterogeneous substances, it exhibits a silver white colour with blueish shades; its texture is lameliated and radiated; it it is brittle, and is not affected by water, or by the atmosphere. Its specific gravity is = 6,860. It can be volatilised by a strong heat; when perfectly fused, and exposed to cool gradually, it exhibits cubical crystals on the surface; it combines easily with sulphur, but very difficultly with mercury; it is not easily acted upon by sulphuric and nitric acid, but is very readily soluble in nitro-muriatic acid. With muriatic acid, it makes that liquid called butter of antimony, which is very corrosive. There are a great number of preparations made of it for medicinal uses.

DIVISION I.

Antimony in the metallic state.

SPEC. I.

NATIVE ANTIMONY.

Antimonium nativum.

Germ. *Gediegener spiesglanz könig.*

Fr. *Antimoine vierge ou natif.*

Dan. *Naturlig spids glass.*

Hung. *Termés pisgoltz.*

It

It was firſt diſcovered by *Swab*, in Sweden, in the year 1748.

Its colour is ſilver white, with a ſtrong luſtre; the texture lamellar; it is ſoluble in nitro-muriatic acid, and ſeparates again from it, when the ſolution is much diluted with water. It is generally mixed with arſenic and iron. Some mineralogiſts believe that it is always alloyed with arſenic. Mr. Sage mixed it with ſulphur, and fuſed it together, and the product reſembled realgar, or red arſenic. He ſays, that the native regulus contained 16 per cent. of arſenic.

Its matrix is generally calcareous ſpar. It is found near Allemont in Dauphiny, accompanied by red antimony, and near Sahlberg in Sweden.

DIVISION II.

Antimony in the mineraliſed ſtate, requiring torrifaction to obtain the metal; emitting when heated, ſulphureous or arſenical vapours.

A. *Mineraliſed by arſenic.*

SPEC.

SPEC. II.

ARSENICATED ANTIMONY.

Germ. *Arſenikaliſcher ſpieſglanz.*

It has a white brilliant luſtre, alſo a lamellar or ſcaly texture; it is found in maſſes of no regular ſhape. When heated, it emits only arſenical vapours.

I have put it down here as a ſeparate ſpecies, as I examined a ſpecimen of native regulus, which was not mineraliſed by arſenic, and was almoſt entirely diſſolved in nitro-muriatic acid, and ſeparated again on weakening the menſtruum with water.

The arſenicated kind is found near Allemant, in Dauphiny—Hungary, and Saxony.

B. *Antimony mineraliſed by ſulphur, emitting ſulphureous vapours when torrified.*

SPEC. III.

GREY SULPHURISED ANTIMONY.

Germ. *Grau ſpieſglanzerz.*

Ital. *Antimonio ſolfureo.*

Fr. *Antimoine ſulfuré.*

Lat. *Antimonium ſulphure mineraliſatum griſeum.*

Its colour is lead grey—ſteel grey—blackiſh. It is found in compact maſſes, having a lamellar, radiated, or ſcaly texture. It is generally found in needle-ſhaped priſmatic cryſtals, cohering more or leſs.

Its regular ſhape is the rhomboidal octahedron, the baſis of which has angles of 88 and 92 degrees; it appears frequently in four-ſided priſms, terminating in four-ſided points—in ſix-ſided priſms, terminating in a point with ſix facets——in truncated four-ſided priſms, more or leſs ſhining, generally with a metallic luſtre.

It

It is ſtaining, and breaks generally into radiated fragments ; its ſpecific gravity is generally = 4,200.

It is ſoft and brittle ; it melts in the flame of a candle by means of the blow-pipe eaſily, and burns with a blue flame ; it evaporates by a continued ſtrong heat, in the ſtate of grey vapours ; when digeſted with nitro-muriatic acid, the metallic parts are diſſolved, and the ſulphur ſeparates and floats on the ſurface.

It contains often a ſmall portion of gold, but which is not worth extraction. The proportion of component parts vary, ſometimes above 70 per cent. metal, and above 20 ſulphur.

It is found in Upper and Lower Hungary, at Cremnitz, and Schemnitz—at Nertſchinſk, in Siberia—in Saxony—Spain, and England.

Its matrix is quarzous, and calcareous, more rarely heavy ſpar. I poſſeſs ſpecimens in which long cryſtals paſs through cryſtalliſed white ſemitranſparent heavy ſpar.

SPEC. IV.

RED ANTIMONIAL ORE.

Germ. *Roth ſpieſglanzerz.*

Born. Cat. Raiſ. *Antimoine coloré rouge.*

Fr. *Mine antimoine rouge.*

Dan. *Rod ſpids glaſmulm.*

Hung. *Veres piſgoltz.*

This ore conſiſts of antimony, ſulphur, and arſenic; it is generally of a light crimſon red colour; moſtly in thin priſmatic capillary cryſtals, which are accumulated and arranged in a diverging, or ſtellated manner. The cryſtals are opaque and friable. It is found in the antimonial mines of Bohemia, Hungary, and Tranſylvania.

I have ſpecimens of antimonial ores, which are covered with a coat of reddiſh brown antimony, of an earthy appearance, and reſembling the kermes mineral, which was given to me for native *kermes mineral.* I ſhall examine it in order to aſcertain whether it contains arſenic, or or whether I ſhall place it, for the future, as a ſeparate ſpecies.

SPEC. V.

PLUMOUS ANTIMONIAL ORE, OR ARGENTIFEROUS ANTIMONIAL ORE.

Germ. *Federerz.*

Hung. *Piſgoldzos ezuſt.*

It has a lead grey colour. It is generally found in thin capillary, or filamentous cryſtals irregularly mixed. It is very little ſhining, is friable, and ſtains the fingers. It conſiſts chiefly of antimony, iron, arſenic, ſulphur, and ſilver.

It is found with the common grey antimony, near Freiberg—in Hungary, and Tuſcany.

It ſeems to be only a variety of the grey antimony.

SPEC. VI.

VARIEGATED SULPHURISED ANTIMONY.

Born. Catal. Raiſon. *Antimoine coloré iriſé.*

Germ. *Buntes or regenbogen farbiges ſpiesglanzerz.*

It has a very beautiful appearance, exhibiting the colours of a rainbow, or thoſe exhibited by the feathers round the neck of the blueiſh kind of pigeons.

It is compoſed of long fibres or filaments of the grey antimonial ore, whoſe ſurface has obtained that appearance by having loſt part of its ſulphur, occaſioned by heat which had been extricated during the decompoſition of other bodies ſurrounding it under the earth, and which ſulphureous particles becoming acidified by the combination with oxygen, had thus re-acted upon its ſurface, and ſo produced that change. It is very ſcarce, and has not been found of late.

It

It was found in a certain antimonial mine of Hungary, in quartz and heavy ſpar.

The following ſpecies are to be conſidered as oxydated antimonial ores, more or leſs altered by acids.

SPEC. VII.

WHITE ANTIMONIAL ORE OR OXYD OF ANTIMONY COMBINED WITH MURIATIC ACID.

Muriate of antimony.

Germ. *Weiſs Spieſglanz-erz.*

It is white, or greyiſh white; it is found in oblong rectangular four ſided plates, in capillary cryſtals joined at the baſis and grown together. The cryſtals have generally a pearl luſtre, a lamellar texture; they are ſemi-tranſparent, reſembling ſomewhat the white lead ore, or white zeolith; they crackle when exposed to heat. When fused with borax upon charcoal, the metal recovers. It consists chiefly of oxyd or calx of antimony and muriatic acid.

It is scarce, and found near Braunsdorf—Freyberg—Przibram in Bohemia; generally accompanied by red blende, galena, grey antimony.

I have a specimen which contains the white antimony and red antimony, both in capillary crystals, placed in a stellated manner.

SPEC. VIII.

YELLOW ANTIMONIAL ORE.

This ore differs from the foregoing, in containing oxyd of lead, from which it has probably obtained the yellow colour.

It is found in four sided shining lamellæ.

It is very scarce, and was found in Hungary.

As to the working of antimonial ores, which are chiefly the sulphurised ores: the ore is first sorted

ſorted and pounded, then torrified in an oven reſembling that of the bakers. A hundred pounds of the torrified ore are mixed with fifty pounds of dried tartar and a little iron; the mixture is fuſed in proper crucibles; after which the metal is found in the bottom of the crucible. The metallic buttons or loaves, exhibit generally a ſtar on their ſurface, particularly if the crucible be placed in a temperature ſo as to cool gradually.

GENUS XIII.

COBALT.

COBALTUM.

Cadmia. Ital. *Cobalto.*
Germ. *Kobalt.*

This metallic ſubſtance was firſt diſcovered by Brandt, in the year 1735.

It is uſed for ſeveral purpoſes, but chiefly and particularly as a colouring matter in the art of painting blue in *freſco*, and on fayence ware, &c.

It is found in nature, mineraliſed by arſenic or ſulphur, in the ſtate of calx, and combined with or altered by acids, perhaps never in the pure metallic ſtate.

It

It is met with in various countries. The mines of Saxony, Bohemia, and Sweden, produce a great quantity. Wherever it is found, it is generally accompanied by ſilver ores.

When freed from heterogeneous ſubſtances, it has a blueiſh grey colour, with a little ſhade of reddiſh, reſembling in appearance moſtly pure iron.

Its texture is the intermediate between granular and ſcaly.

Its ſpecific gravity is = 7000.

It is brittle, and eaſily reducible to powder; is readily affected by the atmoſphere, and a little moveable by the magnet, which has been aſcribed to iron, from which it can ſcarce be perfectly freed. It requires a very ſtrong heat for fuſion, rather more than copper: when in the ſtate of calx or oxyd, it appears generally of a roſe colour; when fuſed with borax, it produces a glaſs of a fine blue, and this colour it occaſions in moſt vitrifiable ſubſtances.—When fuſed with one part of pure ſand, and two parts and a half of potaſh, it makes a blue glaſs, which is reduced by mills to a very ſubtle powder, and is then called *ſmalte*, a blue ſubſtance uſed for blueing by waſher-women. It is ſoluble in nitric acid without the aſſiſtance of heat, and gives a roſe colour to the ſolution.

tion. When evaporated, it cryſtalliſes in needle ſhaped cryſtals, which deliqueſce in the atmoſphere.

It is ſoluble in vitriolic acid, by the aſſiſtance of heat; and when ſaturated with that acid, and evaporated, it cryſtalliſes; the cryſtals are tetrahedal rhomboidal, terminating in a dihedral ſummit, and the combination is decompoſed by ponderous, calcareous, and magneſian earth, and alſo by fixed alcalies. It is perfectly ſoluble in marine and nitro muriatic acid; and the ſolution, when much diluted with pure water, is uſed for ſympathetic ink, which, when written with on paper, and held near the fire, turns blueiſh or greeniſh. Volatile alcali extracts a red colour from it. With nitric acid, it does not produce the ſympathetic ink, only by means of the muriatic acid.

It does not combine with mercury.

DIVISION I.

Cobalt in the mineraliſed ſtate, with ſulphur or arſenic.

SPEC.

SPEC. I.

GREY COBALT ORE. ARSENICATED COBALT.

Germ. *Grauer ſpeiſs Kobalt*, or *grau Kobalterz.*

Swed. *Gra Cobalt malm.*

Hung. *Hamu—Szinü áſványos, Kobalt.*

Dan. *Graau Kobalt malm.*

This ore is chiefly compoſed of cobalt and arſenic. Its colour is ſteel grey, reſembling regulus of arſenic; ſometimes the ſurface is variegated; it has a fine grained compact texture.

It is found in ſolid maſſes, or in ſmall particles, diſperſed in various ſtones, ſometimes ſtalactitical; ſpecular with a particular luſtre, ſo as to reflect the images of bodies like looking glaſs, whence this kind was called *looking glaſs cobalt.* It appears ſometimes dentritical, or reſembling net work, of regular ſhape, as in in cubical, prifmatic, and octohedrical cryftals, with a metallic luftre; the cryftals are brittle, and turn blackifh on long expofure to the atmofphere. It fometimes ftrikes fire with fteel.

When thrown upon red hot charcoal, it emits a garlic fmell, which characterifes the arfenic; when melted with borax, it occafions a blue colour. When diffolved in nitro-muriatic acid, it makes fympathetic ink.

Its matrix is red heavy fpar, calcareous fpar, quartz, &c. it contains often filver.

It is found at Annaberg and Schneeberg, Freiberg, Johanngeorgenftadt in Saxony—at Joachimfthal in Bohemia—Saalfeld in Thuringia—and at Kongfberg in Norway.

B. *Mineralifed by fulphur and arfenic.*

SPEC.

SPEC. II.

WHITE COBALT ORE.

Galena Cobalti.

Fr. *Mine de cobalt blanche.*

Born. Catal. Raiſon. *Cobalt combiné avec arſenic le ſoufre & le fer.*

Germ. *Glanz kobalt*, or *weiſſer ſpeiſs kobalt.*

Swed. *Glants cobalt.*

Hung. *Tündöklö kobalt.*

Gmelin. *Cobaltum pyriticoſum.*

It conſiſts chiefly of cobalt and iron, mineraliſed by ſulphur and arſenic; its colour is deep tin-white-grey, inclining a little to reddiſh, ſometimes variegated.

It is found ſolid, diſperſed, in groupes, ſpecular and knitted. Its texture is granular and lamellar; it has a metallic luſtre. When thrown

thrown upon red hot charcoal, it emits both ſulphureous and arſenical vapours; it does not ſtrike fire with ſteel, and is ſcarcely altered in the atmoſphere.

It is alſo found of regular ſhape, as dodecahedrical rhomboid. The ſurfaces are ſtriated, the ſtriae on one ſide are perpendicular to thoſe of the oppoſite ſide.

When this ore is wrought, the pounded ore is torrified, by means of which the arſenic requiring leſs heat than the ſulphur, is volatiliſed firſt; afterwards the ſulphur is ſeparated, and the calx or oxyd is left behind.

This kind of cobalt ore is found at Schneeberg and Saalfeld. In Norway, the fortification-cobalt, ſo called from its appearance, is found near Riegelſdorf, and near Tunaberg in Sweden.

SPEC.

SPEC. III.

SULPHURISED COBALT.

Born. Catal. Raiſon. *Oxyde de cobalt combiné avec le ſoufre.*

This ore ſeems to contain no arſenic or iron, in which it differs from the foregoing ſpecies; it is alſo richer in metal; it is generally white, ſometimes tarniſhed. When heated, it emits a ſulphureous ſmell; it does not ſtrike fire; and is found in cubical cryſtals without ſtriae.

It is met with in Upper Hungary and Joachimſthal, generally upon quartz.

DIVISION II.

Cobalt ores in the calciform or oxyd ſtate.

A. *Oxyd*

A. *Oxyd of cobalt without acids.*

SPEC. IV.

BLACK OXYD, OR CALX OF COBALT.

Germ. *Schwarzer Erdkobalt en cobalt okker.*

Ital. *Calce di cobalto nigro.*

Swed. *Cobalt jork.*

Dan. *Kobalt mulm.*

Cronſtedt. *Ochra cobalti nigra.*

Fr. *Oxid de cobalt noir.*

This is the pureſt kind of the calciform cobalt ores. It emits no ſulphureous or arſenical vapours when heated.

When fuſed with ſilex and potaſh, it makes a fine blue glaſs; it becomes ſhining when rubbed with the nail of the finger.

It is alſo found of a greater coherency or hardneſs, exhibiting reniform or botrioied pieces,

pieces, refembling flags, but never yet in the cryftallifed ftate, or of regular figure; from its vitreous appearance, it has been called in

German, *Glafsartiger kobalterz.*

Fr. *Mine de cobalt vitreufe.*

By Cronftedt, *Minera cobalti vitrea.*

Both kinds are found at Saalfeld, in Thuringia—at Annaberg, Schneeberg, and Kamsdorf, in Saxony. The vitreous kind particularly at Vitzbichel, in Tyrol.

SPEC. V.

BROWN EARTHY OXYD OF COBALT.

Fr. *Oxide de cobalt brun.*

Germ. *Brauner erd kobalt.*

This kind contains generally a little iron. Its colour is liver-brown—deep afh-grey—and ftraw yellow.

It is found only difperfed in various matrixes; it has an earthy texture; when in the compact ftate and broken, it appears on the infide reddifh.

It is found with kupfernickel, at Saalfeld, and at *Groſskamſdorf.*

SPEC. VI.

YELLOW OXYD OF COBALT.

Its colour is a dirty ſtraw yellow; it is found ſolid—interſperſed, and has an earthy texture; its external characteriſtical mark is its appearing always cracked in various directions.

B. *Oxyd of cobalt combined with acids.*

SPEC. VII.

GREEN OXYD, OR CALX OF COBALT.

Germ. *Grüner erd kobalt, or grüner-kobalt beſchlag.*

Fr. *Oxide de cobalt vert.*

It conſiſts chiefly of oxyd of cobalt, of nickel, and a little arſenical acid. It has its colour coour from nickel, with an earthy appearance, and is generally deposited upon ferruginous clay; when examined by a microscope, it appears in capillary crystals. It is found at Schmölniz, in Upper Hungary; and at Saalfeld, in Thuringia.

SPEC. VIII.

RED OXYD OF COBALT.

Germ. *Rother kobalt okker.*

It consists chiefly of calx of cobalt, and arsenical acid.

There are two varieties of it.

Var. 1. Earthy red oxyd of cobalt.

Germ. *Kobalt beschlag.*

Fr. *Fleur de cobalt superficielle.*

It has a red colour, like pale red roses, or the colour of the peach flower.

It is generally found in an earthy state, of a greater or less degree of coherency, coating

 different

different ſtones—ſeldom botrioid. It has an earthy texture, but leaves a ſhining trace on rubbing.

It ſeems to originate from the arſenical cobalt ore, which has been altered by the abſorption of the baſis of pure air, and thus become acidified.

It is found on ferruginous indurated clay, and on quartz, at Oraviza, in the Bannat of Hungary—at Schneeberg, in Saxony—and at Joachimſthal, in Bohemia. I alſo found it in Ireland, near the lakes of Killarney.

VAR. 2. EFFLORESCENT RED COBALT ORE.

Germ. *Kobalt blüthe.*

Fr. *Fleur de cobalt ſtriée comme l'amyanth.*

Dan. *Kobolt blomſter.*

Its colour is crimſon—cochineal—and peach flower red. It is found diſperſed in, or depoſited upon different ſtones; generally compoſed of very thin capillary priſmatic cryſtals, diſpoſed in a ſtellated manner. The cryſtals are ſhining, ſemitranſparent, and ſoft to the touch. Their regular ſhape is a rectangular four-ſided priſm.

It

It is found upon ferruginous-indurated clay —white quartz, and petrofilex. It is met with at Schneeberg, and Saalfeld—in Silefia—in Sweden—Norway—Joachimfthal, in Bohemia —Saxony—Thuringia—Andreafberg, on the Harz—Allemont, in Dauphiny—Spain, near Guftoa, and Bielfa, in the province of Arragon.

SPEC. IX.

BLUE COBALT ORE.

Its component parts I have not afcertained yet; I fhall examine, and give a more full account of it, in the fupplement to this work.

Its colour is blueifh black; it has an earthy appearance, and is accompanied by red oxyd of cobalt, in a matrix of indurated clay, and quartz. I found fome very fine fpecimens of it, near the lakes of Killarney, in Ireland.

SPEC. X.

VITRIOL OF COBALT, OR SULPHATE OF COBALT.

This being a perfect salt, soluble in water, I have already mentioned it amongst the metallic salts, treated of in the first volume.

THE common mineralised ores of cobalt, may be assayed by first torrifying the pounded ore, to separate the mineraliser, and afterwards fusing the remainder with black flux, in the proportion of 200 grains of the roasted ore, and one ounce and a half of black flux; by these means, the metallic parts are separated. If the metal be combined with iron, or bismuth, it may be mixed with muriate of ammonia, or sal ammoniac, and sublimed, by which means, the heterogeneous metallic parts are carried off, along with the salt, in the upper part of the subliming vessel; the sublimation

tion is repeated, until the ſalt aſſumes a greeniſh tinge.

The working of cobalt ores conſiſts in roaſting the ore in a reverberatory furnace, terminating in a long chimney, into which the vapours are received. The vapours adhere to the ſides, forming a cruſt, which is cleared away by criminals, who are condemned to this work for crimes, that by the law deſerve death. The cobalt ores of Saxony afford a great quantity of arſenic.

When the cobalt is freed from the mineraliſer, it is called zaffer, which is uſed for the making of ſmalt, for painting, &c.

GENUS XIV.

MANGANESE.

MANGNESIUM.

Fr. *Manganese.*
Germ. *Braunstein.*

This metallic substance seems, after iron and gold, to be the most frequently diffused through the earth, and even in vegetables. As a peculiar metal, it was first ascertained by GAHN, and SCHEELE, in the years, 1774 and 1777.

It is scarce ever found in, or approaching to the metallic state, but always in the state of calx, or combined with oxygen, probably on account of the great affinity, or attraction, which it seems to have to that principle; in this state, it has proved a useful substance.

It

It appears to be capable of combining with a greater portion of the basis of pure air, than any other metal, and parts with the greatest part of it again, by the mere application of heat, when exposed to it in close vessels; on this account, it is frequently used in chemistry, to procure a great quantity of pure air or oxygenous gas; it communicates that principle also to certain acids, particularly to muriatic acid, when distilled over it, which causes the same to escape, in the state of an elastic fluid, or gas, called suroxygenated muriatic gas, or *diphlogisticated muriatic acid.* This last has the property of depriving most vegetable substances of their colour, both in the state of gas, and also when mixed with water, by which it is absorbed; hence it is employed in manufactories for bleaching linen, and rags for the manufacturing of paper, &c. However it being found, that in the state of gas, it corroded or destroyed part of the stuff, this effect was mitigated, by combining it with pure potash, dissolved in the same water by which it was absorbed; by these means, it answers the purpose of bleaching much better, and is neither so noxious or destructive to the animal œconomy, of which we have experienced many bad consequences.

This

This ſubſtance in the ſtate of oxyd, was alſo found to have the property of depriving certain earthy and metallic ſubſtances of their colour, when mixed and fuſed with them in certain proportions; for which reaſon, it has now been employed in glaſs manufactories, to remove the green colour of the common green glaſs. Laſtly, it is uſed in the manufactories of certain earthen wares, as the black earthen ware of Mr. Wedgewood, to which it communicates the black colour. More of its qualities may in proceſs of time be diſcovered.

The pure metal can only with great difficulty be obtained from the ore, that is, by frequent fuſion with charcoal, and other contrivances. The metal requires alſo a ſtronger heat for fuſion, than any other metal. When pure, it reſembles iron as to colour. It is alſo harder than other metals. When expoſed to the atmoſphere, it ſoon abſorbs oxygen, and falls into powder. Its ſpecific gravity is found = 6,800.

When fuſed with borax, it produces a deep red glaſs; when mixed in a certain proportion with nitre, and expoſed in a crucible for a ſufficient time to heat, the mixture obtains the property, when thrown into water, of exhibiting three different colours one after the other, as green, purple, and ſcarlet, and at laſt, all the colours diſappear again; this mixture is called chamelion. It is ſoluble in acids, and is precipitated from the acid, by alcali, in the ſtate of a white powder, which has alſo the peculiarity of turning black, when expoſed to the atmoſphere, and much ſooner in pure air. When ſulphuric acid is poured on it, it has been obſerved to throw out light. When fuſed with copper, it renders it white, and remains malleable. It does not combine with ſulphur, or with mercury.

SPEC. I.

NATIVE METALLIC MANGANESE.

Magneſium metallicum.

It was found in the ſtate of greyiſh white ſmall globules, which when expoſed to the atmoſphere, fell to a black powder. The globules when firſt found, admitted to be flattened a little with the hammer; ſuch was met with in the county of Foix, in France, and near Carinthia, and Hungary. I have never ſeen any, and can, therefore, give no fuller account of it, it, than what I have found mentioned by other authors.

SPEC. II.

GREY OXYD OF MANGANESE.

Magnesium ochraceum griseum.

Germ. *Graues braunsteinerz.*

Born. Catal. Raison. *Oxide de manganese, souillé de fer. Combiné avec une grande portion d'oxygene.*

Its colour is steel grey, with a metallic lustre. It is found solid with a lamellar texture; gives a black trace, and stains paper a little. It is found in lamellæ—in needle-shaped crystals, which are chiefly disposed in a radiated or stellated manner. The shape of the crystals exhibits six-sided prisms——tetrahedral rhomboidal prisms, which are longitudinally striated, the degrees of the angles are 65° and 115°. When heated in close vessels, they emit pure air.

It is found particularly fine at Piemont—at Ilfeld on the Harz—in Dauphiny—Bohemia —Carinthia——

Carinthia——Jamaica, and in various other countries.

It is often mixed with calcareous earth, ponderous earth, or baryt; magnefia, and fixed air.

SPEC. III.

BLACK CALCIFORM MANGANESE.

Germ. *Schwarzes braunfteinerz.*

Fr. *Oxide de manganèfe noir.*

Its colour is black—greyifh black, or iron black, refembling fuligo or foot. It is found in folid lumps, difperfed in different ores or ftones—coating other minerals—cellular—dentritical, or upon glaffy hematites——kidney fhaped——botrioid, or ftalactitical; and alfo, but more feldom, in acute angular octahedrical cryftals, which have a luftre, and a lamellar texture.

It is found near Kamfdorf, and Könitz—Piemont—Carinthia—Thuringia. In England and

and Ireland, it is found in confiderable quantity, and rather more of a brown colour.

To this belongs alfo the fubftance called wadd, which is found in Derbyfhire, and which difcovers the peculiarity of becoming red hot, when mixed with linfeed oil on expofure to air.

SPEC. IV.

REDDISH WHITE OXYDATED MANGANESE.

Manganefe combined with a lefs portion of oxygen.

Fr. *Oxide de manganefe blanc ou coleur de rofe.*

Germ. *Röthlich weifes braunfteinerz.*

Its colour is whitifh, or that of rofes; fometimes brownifh red. It is found folid and interfperfed—botrioid, and alfo in lenticular and pyramidical cryftals. It is found in certain mines of Hungary, and Tranfylvania, mixed with filex, and conftitutes the matrix of the

the auriferous ores. It is foluble in nitric acid, the folution being colourlefs, and the precipitate occafioned by alcali, white, which when heated, becomes black.

It was analyfed by Ruprecht, who found it containing 55 of filex, 35 of manganefe in the ftate of oxyd, and a little iron, and argillaceous earth, in a hundred parts.

THE following three metallic fubftances differ from the other metals, in affuming the property of acids, when combined with a fufficient quantity of oxygen, or the acidifying principle.

GENUS

GENUS XV.

MOLYBDENA.

This metal was firſt aſcertained and deſcribed by *Hielm* in the year 1784.

The ſubſtance which contains it, had been often confounded with plumbago or black-lead, from which it differs conſiderably, as I ſhall point out. Several chemiſts have not been able to ſucceed in the ſeparation of the metal from the ore. Mr. Hielm ſays, it has a ſteel grey colour, and is very brittle; it is only ſoluble in the nitric and arſenical acid; when nitric acid is diſtilled over this metallic ſubſtance, it leaves a white calx or oxyd behind, which is called the molybdenic acid, and which has the property of decompoſing nitrate and muriate of baryt; in the dry way, it diſengages the nitric acid from common nitre, and the muriatic acid from common ſalt, when expoſed together in a retort for diſtillation.—

The

The acid itſelf ſeems unalterable in fire, like the arſenical acid. Other acids have ſcarcely any effect upon this metallic ſubſtance.

The ſpecific gravity of the acid is = 3460, and from analogy, that of the metal about = 6900.

It combines with ſulphur, and the mixture is called ſulphuriſed molybdena, in German *Waſſerbley.*

It effervеſces with alcali when fuſed by fire.

This metallic ſubſtance is only found in nature, combined with ſulphur.

SPEC. I.

SULPHURISED MOLYBDENA, OR MOLYBDENA MINERALISED BY SULPHUR.

Germ. *Waſſerbley glanz.*

Cronſtedt. *Molybdena membranacea nitens*

Born. Catal. Raiſon. *Acide molybdenique combiné avec le ſoufre.*

Its colour is lead or ſteel grey, with a luſtre. It has a lamellar texture, and is compoſed of thin lamellæ, placed over one another; the lamellæ are curved, flexible, and ſtain paper with a luſtre, more than plumbago.

It is generally found compact, and ſeldom in particles.

Its ſpecific gravity is generally = 4,700.

It can be cut with a knife, is fatty to the touch, can be volatiliſed by a ſtrong heat, and emits ſulphureous vapours.

It is found likewiſe of regular ſhape, as in ſix ſided plates, and in ſix ſided priſms, terminating in ſix ſided pyramids, by double truncation; ſuch a ſpecimen Mr. Raſpe poſſeſſed, which I ſaw. Its matrix is feldſpar, lithomarge, and quarzous rock.

It is found in Iceland—Sweden—Spain—at Altenberg in Saxony—at Schneeberg and Schlackenwald—in France—at Kolynan in Siberia. It is alſo found in rocks containing wolfram and tin ores.

The terra auſtralis ſeems to be mixed with molybdena.

GENUS

GENUS XVI.

ARSENIC.

ARSENICUM.

That this ſubſtance is a peculiar metal, was firſt aſcertained by Schroeder in the year 1641. Mr. Monnet in the year 1773, aſcertained its properties more fully.

It is found in many different parts of the earth, both in the metallic ſtate, and mineraliſed by ſulphur, and alſo in the ſtate of calx or oxyd.

It is uſed for ſeveral purpoſes, according to its different ſtates, each of which I ſhall mention ſeparately.

Perhaps it would be laudable, if an expreſs law prevented the ſelling of common arſenic to unknown people in the ſhops of druggiſts, where the purpoſe or pretence was ſo ſlender as that *of destroying rats, &c. at least more caution should certainly be impressed on the minds of those who sell, and of those who buy this pernicious mineral; for the former do not often consider the unhappy consequences, which may arise from even a careless use of it, while the latter are frequently so heedless in its application, by leaving it open, and in improper places, that however innocent intention has been, numberless are the instances on record, of the lamentable mischiefs which this poison has occasioned. It should be remembered, that there are other poisons more safe to man than arsenic, which might be used for destroying noxious animals, and that arsenic preys sufficiently upon human life, if we come to number the victims who are occupied, and by degrees destroyed, in its mines and several workings.*

When the metal is freed from other substances, it has a lead grey colour, a lamellar texture, and a slight lustre; it becomes blackish or purple when exposed to air.

Its specific gravity = 8,310.

It is not acted upon by water, but readily by nitric acid.

When exposed to heat, it may entirely be volatilised, during which it emits a garlic like smell; it is dissipated in the state of white vapours, which may be collected on a piece of polished

poliſhed copper plate, held a little diſtant over the crucible in which it is ignited. When fuſed with common glaſs, it deprives it of colour; it renders copper white, and iron yellow, gold and zinc grey.

When the metal is perfectly fuſed, and ſuffered to cool gradually, it exhibits an octahedrical ſhape. When mixed and fuſed with ſulphur, it produces a red mixture, or the realgar or red arſenic, as it is called.

DIVISION I.

Arſenic in the metallic ſtate, free from ſulphur.

SPEC. I.

NATIVE METALLIC ARSENIC, TESTACEOUS ARSENIC.

Arſenicum nativum.

Germ. *Gediegener arſenik-könig*, alſo *ſcherben kobald*, & *Fliegenſtein.*

Fr. *Arſenic natif.*

Dan. *Naturlich arſenic.*

Hung. *Termes egér kö.*

It conſiſts chiefly of arſenic, and a little iron. Its colour is generally lead and iron grey. Its texture is lamellar or teſtaceous, the lamellæ are a little curved and ſonorous.

Its ſpecific gravity is generally = 8,308.

When freſh broken, it exhibits a luſtre, but becomes ſoon tarniſhed in air.

It is brittle, and eaſily pulveriſable. When boiled with water, it communicates a ſufficient poiſonous quality to kill flies, for which purpoſe it is frequently uſed in Germany, and hence

hence it has probably obtained the name *Fliegenſtein.* When expoſed to a ſufficient heat in a crucible, the arſenic flies off, and leaves an iron ſlag behind.

It is generally found in cobalt mines, as near Freiberg and Annaberg in Saxony—at Joachimſthal in Bohemia—at Kongſberg in Norway.

DIVISION II.

Arſenic in the ſtate of calx or oxyd.

SPEC. II.

WHITE OXYD OF ARSENIC.

Arſenicum album.

Germ. *Weiſſer arſenik-kalch.*

Fr. *Arſenic blanc ou oxide d'arſenic blanche.*

This is ſcarce; its colour is naturally whitiſh, but when expoſed to heat, it becomes blackiſh.

Its ſpecific gravity is = 2477.

It is entirely volatiliſed by heat in the ſtate of white vapour, which have a garlic ſmell.—It is the only oxyd of metals which emits a characteriſtical ſmell when expoſed to heat.—It is ſoluble in nitric acid, but leſs in muriatic and vitriolic acid; it is ſoluble in water, and particularly when aſſiſted by heat. When fuſed with ſulphur, it produces, according to the proportion of ſulphur, a yellow or a red maſs.

It is generally found of an earthy appearance, or as an effloreſcence, coating native or metallic arſenic; ſeldom in the cryſtalliſed ſtate, exhibiting octahedrical cryſtals, or tetrahedral truncated priſms, or three and four ſided pyramids, which have probably been occaſioned by ſubterraneous heat.

It is found at Schmölnitz in Hungary—at Andreaſberg on the Harz—at Joachimſthal in Bohemia, and in Tranſylvania.

DIVISION III.

Arſenic mineraliſed by ſulphur, emitting ſulphureous vapours when thrown upon red hot charcoal, not ſoluble in nitric acid.

SPEC.

SPEC. III.

SULPHURISED ARSENIC, OR ORPIMENT.

There are two varieties of this kind, which differ from each other by the different colour and ſolidity, or coherency, occaſioned by the different proportions of its component parts, and by the different degrees of heat to which it has been expoſed, and which are differently named.

VAR. I. YELLOW SULPHURISED ARSENIC.

Lat. *Aurum pigmentum*, or *reſigallum*.

Swed. *Rauſch gelb*.

Cronſt. *Calx arſenici ſulphure mixta flava*.

This kind contains leſs ſulphur than arſenic, generally 90 parts arſenic, and 10 of ſulphur. Its colour reſembles that of lemon or yellow brimſtone, inclining ſometimes to greeniſh, reddiſh, or orange.

Its

Its texture is generally lamellar, and the lamellæ are so soft as to be cut with a knife, and a little flexible, and have often a beautiful brilliant lustre, which is improved by the scarlet red shades.

Its specific gravity is generally = 5315.

When exposed to heat, it becomes blackish; and when fused in a close vessel, it becomes red; it is often semi-transparent in a light degree. When exposed to a long continued heat, it evaporates, leaving a small portion of earthy parts behind.

It is found stalactitical, globular, and testaceous, or in oblong and broad lamellæ, never as far as I have known, in the crystallised state.

It is found in the bannats of Hungary, and in various other parts.

When reduced to fine powder, it is used in paintings.

VAR. 2. RED SULPHURISED, OR RUBY ARSENIC.

Realgar. *Arſenicum rubrum.*

Fr. *Realgar natif.*

Germ. *Rother arſenik.*

Cronſt. *Calx arſenici ſulphure mixta rubra.*

Gmelin. *Arſenicum ſadaraca.*

This kind conſiſts of a greater portion of ſulphur; 84 of arſenic, and 16 of ſulphur, generally form the proportion. Its colour is aurora red, or ruby red, generally of an equal colour, and it appears more as a homogeneous ſubſtance; it is more tranſparent than the afore-mentioned variety; it is ſhining, but not ſo bright as the yellow orpiment.

Its ſpecific gravity is = 3,300.

It is found in compact ſolid maſſes, and frequently of a regular ſhape, as in tetrahedral and hexahedral rhomboidal priſms, longitudinally ſtriated, and often terminating in tetrahedral ſummits, or variouſly modified.

It

It is common in China, where it is made into vaſes, pagodas, and other ornamental works. The Indians make uſe of theſe veſſels to procure a purgative medicine; for ſuch purpoſe they leave vinegar or lemon juice for ſeveral hours in the veſſel, and afterwards drink it.

Red arſenic is commonly found near volcanos, as at the Solfatara near Naples—in the mines of Nagyag in Tranſylvania—in the mines of Felſobanya in Upper Hungary—near Joachimſthal in Bohemia, and at Marienburg in Saxony. Its matrix is quartz, heavy ſpar, and ferruginous clay.

SPEC. XIV.

PYRITICAL ARSENICAL ORE, OR ARSENICAL MUNDIEK;

OR,

ARSENIC AND IRON MINERALISED BY SULPHUR.

Germ. *Miſpickel & giftkies.*

Swed. *Arſenikaliſch-kies.*

Hung. *Egér-kö kova.*

Cronſtedt.

Cronstedt. *Arsenicum metalliforme ferro mixtum crystallisatum.*

Fr. *Pyrite blanche arsenicale.*

Born. Catal. Raison. *Arsenic combiné avec le fer & le soufre.*

Its colour is greyish or silver white, sometimes variegated. It has a slight pyritical lustre; it often strikes fire with steel.

It is found compact in solid masses, having no particular shape, deposited upon, or dispersed in different ores, but frequently also of regular shape, as in cubes, in rhomboidal four sided truncated prisms, which sometimes terminate in dihedral summits, with triangular plans,—octohedral; the surface is generally striated.

When exposed in a close vessel, it sublimes and forms orpiment, leaving the iron behind.

Its matrix is spatous iron ore, fluor, quartz, blende.

It is found at Altenberg, Schneeberg, Freiberg, and Ehrenfriedersdorf in Saxony—at Joachimsthal in Bohemia—in Silesia—Tuscany, and on the Harz.

GENUS

GENUS XVII.

SCHEELIUM, WOLFRAM, OR TUNGSTEN.

That this ſubſtance is a peculiar metal, was firſt diſcovered by Meſſrs. D'Elhujars, in the year, 1783. Mr. Scheele extracted this metal from the ore, commonly called wolfram.

Its ſpecific gravity has been variouſly ſtated by authors, by ſome as 17,000, and by others, leſs; this aroſe from the difficulty or ſucceſsfulneſs which they experienced in obtaining the metal in a pure ſtate. The metal has a reddiſh brown colour—a lamellar texture, and is of the hardneſs of biſmuth; its ſuperficial luſtre is rather yellowiſh.

Vinegar is ſaid to extract a blue colour, when digeſted with it, by heat. It is leſs fuſible than mangneſe. Its oxyd is of an acid nature,

nature, of a yellow colour, and enters into combination with all metals.

It is ſoluble in ſulphuric-nitric, muriatic, and nitro-muriatic acid, and is converted by them into an oxyd. The oxyd combines alſo with alcalies, but is precipitated again from them by nitric acid. The oxyd aſſumes a blue colour with the muriatic acid.

This metal is never found in nature in the metallic ſtate, only in the ſtate of calx, combined chiefly with calcareous earth, and with manganeſe and iron.

Its uſe is not yet known.

SPEC. I.

SPARRY TUNGSTAT OF LIME.

Swed. *Tungſten.*

Dan. *Tung-ſpat.*

Germ. *Schweer-ſtein.*

Ital. *Pietra della tungſtein.*

Fr. *Wolfram de coleur blanche ou mine d'etain blanche.*

In

In this ore the metal is combined with oxygen and calcareous ſpar. It is white, yellowiſh white, and yellowiſh grey, and has a ſparry appearance, is ſhining, and has a lamellar texture; it is ſemitranſparent; it is found ſolid, diſperſed, and cryſtalliſed, as in acute angular octahedrons, or double tetrahedral pyramids. Its ſpecific gravity is = 6066. It decrepitates, when expoſed to the action of the blow-pipe; it effervesces with ſoda, becomes blue when fuſed with microcoſmic-ſalt, or phoſphate of ſoda. Digeſted with muriatic acid, it turns yellow.

It is found at Schonfeld, in Bohemia; near *Schlackenwald*; and in Cornwall, according to Mr. Raſpe's account.

It is often confounded with the white tin ore, as it is alſo found in tin mines.

SPEC. II.

WOLFRAM, OR MANGANESEOUS WOLFRAM.

Fr. *Tungſtate mangeneſié, alſo, Ecume de coup.*

Ital. *Cicaſro wolfram.*

This

This ore is chiefly compoſed of oxydated metal of wolfram—oxyd of mangàneſe, occaſionally a little iron and quartz.

Its colour is dark black; it has a metallic luſtre, and a lamellar texture; it is brittle, and when pulveriſed, the powder appears brown; it is very heavy; its ſpecific gravity being generally about 6,835.

It is very refractory in fire.

It is found in ſolid maſſes in the ſtate of layers, interſected by quartz, or a talcous ſubſtance; ſeldom in the ſtate of ſmall particles interſperſed, but oftener of regular ſhape, as in ſix-ſided broad compreſſed priſms, terminating in dihedral ſummits, or by four facets. The cryſtals are generally longitudinally ſtriated; when fuſed with borax, it produces a greeniſh glaſs.

It is found in England—Siberia—*Zinnwald*, in Bohemia—at Ehrenfriederſdorf, in Saxony, &c.

To this may be added, the ſubſtance called *Kalin*, by the Chineſe, which is a mixture of wolfram, and white tin-ſtone.

GENUS XVIII.

URANIUM.

URANITES.

Germ. *Uran.*

This new metal was discovered by that excellent, and expert experimental chemiſt, Mr. Klaproth, in the year, 1790. He firſt ſeparated it from the mineral, called in German, *Pechblende.* Its colour is deep grey, with a ſlight luſtre; its ſpecific gravity is = 6440; it is ſoft enough to be cut with a knife; it is ſoluble in nitric, and in nitro-muriatic acid, from which it cannot be precipitated by metallic zinc. When fuſed with glaſs flux, it occaſions a light brown colour.

It has, as yet, not been found in the metallic ſtate, but in the ſtate of calx or oxyd, and mineraliſed neralifed by fulphur. Its ufe is not yet afcertained.

SPEC. I.

SULPHURISED URANIT.

Germ. *Pecherz*——*Pechblende.*

Its colour is iron, or brownifh black, greyifh and greenifh black, fometimes variegated on the furface.

It has a dull appearance, and is brittle; when frefh broken, it is a little fhining; its texture is conchoidal; it is found folid and difperfed, but not yet cryftallifed; it is feven or eight times heavier than diftilled water; it emits fulphureous vapours when expofed to fire. It is found at Johanngeorgenftadt.

SPEC. II.

CALCIFORM, OR OXYD OF URANIT.

There are two varieties known.

VAR. I. EARTHY OXYD OF URANIT.

Germ. *Erdiger Urankalch.*

Its colour is lemon, or brimſtone yellow; it has an earthy texture; ſtains paper a little; when thrown upon red hot charcoal, it emits no ſulphureous vapours. It is found ſolid—diſperſed through, and depoſited upon other ores.

This, and the following variety, are found in the mine Georg Wagsfort, at Johanngeorgenſtadt, and Joachimſthal, in Bohemia.

VAR. 2. SPATOUS URANIT.

Uranium ſpatoſum.

Germ. *Uranit-ſpath, or chalcolith, or verhärteter urankalch.*

It has an emerald, or graſs green colour, and is generally found cryſtalliſed in cubes—

in

in four-ſided plates, bevelled on the edges—and in hexahedral priſms. The cryſtals are ſemitranſparent, and give a greeniſh white powder.

It conſiſts chiefly of oxyd, or calx of uranit—carbonic acid, or fixed air, and a little copper, from which it ſeems to have obtained its colour.

Whether the mineral called manakanite, by Mr. Gregor, will yield a new metallic ſubſtance, the continued experiments of that ingenious philoſopher, will, no doubt, ſome time or other inform us.

REFLECTIONS

ON THE EXAMINATION

AND MANNER OF DESCRIBING

MINERALS.

A Practical mineralogist, who is in the habit of examining different mineral products, may sometimes, with little difficulty, procure such knowledge of a mineral, as will enable him to distinguish it, and to place it in his collection, arranged according to his own fancy or conveniency; but it requires a little more attention to the subject, in order to describe a mineral substance, both as to appearance and distinguishing property, in a manner to be well understood by others, to whom such knowledge

knowledge is to be conveyed. This deficiency I have often felt myſelf; and in order to remove ſome of the deficiencies, I have attempted to trace out a plan which I now make uſe of, and which I have taken the liberty to propoſe to thoſe Students, who intend to make application to that part of the Science of Mineralogy.

Sec. I.

TERMS of expreſſing, and a methodical arrangement of the manner which may be uſed in deſcribing the general appearances and qualities of mineral products, as they occur to our ſenſes; or in the order as they may be aſcertained, to point out their characteriſtical marks and diſtinguiſhing qualities.

If the mineral which is to be deſcribed, prove to be a ſubſtance not noticed before, it ſhould be diſtinguiſhed by a name, which either expreſſes its principle component parts, if they can or have been aſcertained, or ſuch a name as expreſſes its characteriſtical mark or property, by which it differs from other bodies.

There is little propriety, and no uſe in naming a mineral after the perſon by whom it is diſcovered, as has been often the caſe.

Sec. 2.

FORMAL of deſcribing the appearances and qualities of a mineral.

E. g. It is a white, ſolid, tranſparent, or opaque ſubſtance; it is ſhining, or hath a luſtre; its ſhape exhibits a tetrahedral, ſhort, compreſſed, or flattened priſm, which terminates in both ends, in a tetrahedral, ſhort, or obtuſe pyramid, the ſides of the pyramid proceed from the ſide edges of the priſm. The ſurfaces of the priſm are longitudinally ſtriated. It is greaſy to the touch, and is heavier than fluor.

Its ſpecific gravity is = weighed in diſtilled water of 60° or —— temperature of Fahreinheit, or —— ſcale; as to its hardneſs, it ſcratches rock cryſtal, or ——— ; it ſtrikes fire with ſteel, or with flint; or it is ſcratched by ruby or rock cryſtal, or ——— ; or its ſurface can be ſcraped by a hand knife, and the particles

particles separated by scraping, appear white or ——— ; it leaves a shining yellow, or —— trace on the touchstone, or it stains paper. It is malleable, or brittle. It is flexible and elastic; its texture is streight or curved, lamellar, and it breaks in rhomboidal pieces. It has a disagreeable, or —— taste; it is electric when rubbed or heated, or it transmits the electric matter when isolated; it is magnetic, or it is attracted by the magnet. It emits a sulphureous, bituminous, or ——— smell when rubbed, scraped, or ignited, or a clayey smell on breathing on it. It emits a phosphorescent light when scraped with a knife in the dark, or becomes luminous when ignited upon a red hot iron held in the dark. It is seemingly affected or altered by the atmosphere.

It is soluble in water heated to 212 degrees of Fahr. scale, in the proportion as to ——. When exposed to, or heated with the blow-pipe, it crackles and splits asunder; it is volatile, or fixt in an ignited crucible, and burns with a green or —— flame. It swells before the blow-pipe, or fuses; it deflagrates with nitre or with charcoal, when thrown into an ignited crucible. It recovers (if metallic) upon charcoal when ignited by the blow-pipe; it fuses, is dissolved, or is only divided when fused

fused with soda, borax, or with microcosmic salt, either with or without effervescence or ebullition.

It makes glass when fused with soda or borax, and gives a blue or —— colour to the latter. It is not acted upon, or it is totally or partly dissolved in nitric-muriatic, sulphuric or nitro-muriatic acid, with or without effervescence, when heated only, or without: the gaz separated by the effervescence, is absorbed by lime water. The solution exhibits a green or —— colour, and has a bitter or sweetish taste when saturated.

Its principle component parts, and their proportion to each other, if they have been ascertained by chemical analyses, are ——; its usefulness for technical purposes to which it may be employed, as in potteries, &c. or for manure, if in sufficient quantities. The country, place and situation where it is found, and what its matrix.

In this list of expressions, I think I have mentioned an example of most of those appearances and marks which a mineral may exhibit, and of which one may take notice in the examination and description of minerals in general. For more variations, Vide Vol. I. from page 21 to 34.

The

The application of the afore-mentioned lift, may be underftood by the following examples :

E. g. Yellow tranfparent FLUOR SPAR.

It is a yellow, folid, fhining, and tranfparent fubftance, refembling, in fome refpects, yellow tranfparent amber. Its regular fhape is a cube; its furface is naturally fmooth and polifhed; its fpecific gravity is = 3,144 weighed in diftilled water of 60 degrees temperature, according to Fahr. fcale; as to hardnefs, it exceeds that of common calcareous fpar; but its furface can be fcratched with a knife, and does not ftrike fire with fteel. Its furface can be polifhed; it is brittle, and has a curved lamellar texture, and breaks in cubical pieces. It is not acted upon, or altered by the atmofphere, nor foluble in water. When fuddenly heated, it crackles and fplits afunder, and becomes luminous, emitting a phofphorefcent light. It is fixed, and fufes in fire *per fe*, and fo with borax before the blow-pipe, without effervefcence. It is not foluble, nor acted upon by nitric or muriatic acid. When reduced to powder, and mixed with an equal quantity of concentrated

concentrated ſulphuric acid, it emits ſtrong ſuffocating acid vapours, which corrode and diſſolve glaſs, and the remainder becomes ſelenite. It yields by decompoſition, fluoric acid and calcareous earth. Its matrix is generally calcareous or heavy ſpar. It is found near Freiberg in Saxony, but not frequently. It ſerves for ornamental work. *(Its place in the ſyſtematical arrangement of ſtones, is to be aſcertained by chemical examination, which I ſhall illuſtrate hereafter.)*

Example of a Metallic Subſtance.

E. g. GALENA, or ſulphuriſed cryſtalliſed LEAD ORE.

It is a metallic ſubſtance; it exhibits the intermediate colour betwixt lead and ſteel, with a bright metallic luſtre. It is ſolid, opaque, and heavy.

Its ſpecific gravity is = 7000.

Its regular ſhape is a cube; as to hardneſs, it can be cut with a knife; it is brittle, has a lamellar texture, and breaks into cubical pieces; when ignited, it emits ſulphureous vapours, crackles and fuſes eaſily. When tor-

rified

rified and freed from the fulphur, it leaves about 60 *per cent.* of calciform ore, which when ignited with charcoal, yields the metal.

It is foluble in muriatic or fulphuric acid, but when digefted with nitric acid, the fulphur is feparated, floating on the furface, and the metal is diffolved by the acid, from which it is feparated again by muriatic acid.

It is generally accompanied by fluor, calcareous, or heavy fpar, and is found in metallic gangues in Flotz Mountains.

Sec. 3.

Specimen of rocks compofed of different fubftances, diftinguifhable by the appearance without chemical decompofition.

E. g. A certain fpecies of GRANIT of an irregular mixture of conftituent parts.

It is diftinctly compofed of three different fubftances, which are blended and cemented together, without any regular order or equal proportion, and form a compact mafs; two of the conftituent parts difcover a regular fhape more

more or lefs perfect; and the third appears to have been the cement which exhibits no marks of a regular fhape.

Subftance 1. FELDSPAR.

It is a greyifh, white, fhining, compact, and opaque fubftance of a rhomboic fhape; it is lefs hard than quartz, but harder than fluor; it does not ftrike fire like quartz, at leaft in a much lefs degree. Its furface can be fcratched with a knife. Its fpecific gravity = 2.500. It is brittle, and has a lamellar texture; it breaks in rhomboic fhaped pieces; it is but flowly acted upon by the atmofphere, and not at all by water. When expofed to the blow-pipe, it does not crackle; it is fixed, but fufible *per fe* in a ftrong heat; it alfo fufes with borax without effervefcence; it is acted upon by, and part of it is foluble in nitric acid, when heat is applied.

Subſtance 2. MICA.

It is a greeniſh and yellowiſh grey, ſhining, ſemitranſparent, and light ſubſtance, apparently compoſed of hexahedral thin plates, or lamellæ, which are flexible and elaſtic.

Its ſpecific gravity is = 2,500.

It is tough, ſoft, or greaſy to the touch; it can be cut with a pair of ſciſſars, and eaſily be divided into thin lamellæ; it is not acted upon by the atmoſphere, or by water, and not readily ſoluble in the ſulphuric, nitric, or muriatic acid. When expoſed to the action of the blow-pipe, it does not crackle, nor fuſe *per ſe*; it is divided into ſmaller particles by ſoda, by means of the blow-pipe.

Subſtance 3. QUARTZ.

It is a milk white ſhining, ſolid, and ſemitranſparent ſubſtance. It exhibits no particular ſhape; its ſpecific gravity is = 2,680. It is very hard, and ſtrikes fire with ſteel, and is harder than glaſs; it can be ſcratched by ruby, but

not

not with a knife. It is brittle, and breaks in acute angular irregular pieces. It has a conchoidal texture; it is not acted upon by the atmosphere, or by water, or by any acid, except the fluoric acid, in which it is mostly soluble. When exposed to the action of the blow-pipe, it cracks; by a strong fire, it is not fusible *per se*, and is permanent. It fuses with soda and potash, with which it makes glass, and with a larger portion of potash, it makes also a glass, but which deliquesces by absorbing moisture from the surrounding atmosphere, and takes the appearance of a jelly. It incloses the two aforementioned substances, like a cement.

ESSAY

ESSAY,

OF A

METHOD *for examining* MINERALS,

By which we may be enabled to aſcertain the diſtinguiſhing characters, and principal prevalent component parts, of a mineral ſubſtance; and to determine thereby, the claſs, diviſion, order, genus, and ſpecies, to which it may accordingly belong, and be placed in the ſyſtematical arrangement, which I have adopted. This method will be found applicable by thoſe who are acquainted with the rudiments of chemiſtry.

AS many mineral ſubſtances are ſubject to undergo alteration, and mixture, whereby their appearance, and part of their qualities is altered; and as likewiſe many minerals bear ſome reſemblance to one another; it becomes ſufficiently obvious, that very little can be expected and depended upon, from the appearance of minerals, in aſcertaining and claſſifying them; and as there are ſeveral inſtances that have happened, even to old profeſſors of mineralogy, who have been miſled by the appearance, the more imperfect muſt ſuch marks be for beginners in this ſcience.—We muſt therefore have alſo recourſe to ſuch characters of minerals as are more conſtant, and may be eaſily aſcertained.

MINERAL SUBSTANCES IN GENERAL,

ARE DIVIDED

Into four general Claſſes.

1. Into SALTS.—2. EARTHS and STONES.
3. METALLIC SUBSTANCES, and—
4. COMBUSTIBLE BODIES.

We ſhall begin with diſtinguiſhing the firſt claſs, comprehending ſalts, which are the moſt ſimple

ſimple and eaſieſt to be aſcertained, and which are found in the earth in a concrete ſtate.

EXP. I.

We examine a ſubſtance whether it is ſoluble at leaſt in 30 times its weight, or leſs, of diſtilled water of a moderate temperature, between 100 or 120 degrees, indicated by Fahreinheit's ſcale, whether it cryſtalliſes on evaporating the filtered ſolution, and the cryſtals do not burn with a flame, when thrown into an ignited crucible; it then belongs to the ſalts, which conſtitute the

1ſt CLASS.

EXP. I.

We then have to aſcertain the order to which it may belong. For that purpoſe, we firſt try, whether when diſſolved in water, it changes the litmus paper red, or whether it occaſions an effervеſcence with mild potaſh, (that is, potaſh containing fixable air) and if

when neutralifed, or faturated with potafh, no copious precipitate is produced, it is
ORD. I. diftinguifhed to be an uncombined ACID, which characterifes the firft order in the clafs of falts, not neutralifed.

EXP. II.

We then have to afcertain the fpecies. If it is foluble in fpirits of wine, and can be volatilifed by heat, we then have afcer-
SPEC. 1. tained it to be the BORACIC ACID, and thus the firft fpecies.

EXP. I.

If a faline fubftance diffolved in water, changes the blue colour of an infufion, or fyrop of violets green, and the yellow turmeric paper brown: if it effervefces with nitric acid, or neutralifes it; if it decompofes the folution of fulphate of magnefia, or alum, it is then diftinguifhed to be an ALKALINE
ORD. II. SALT, and thus comes under the fecond order of falts, which are not neutralifed.

EXP.

EXP. II.

We then have to aſcertain by its other properties, the ſpecies under which it is known.

If it does not diliqueſce, when long expoſed in a moiſt atmoſphere; if, when ſaturated with muriatic acid, and evaporated, it is found not ſoluble in ſpirits of wine; if it is not volatile by heat; it is then diſtinguiſhed to be SODA, or MINERAL ALKALI. SPEC. I.

EXP. I.

If a ſaline ſubſtance is found not to effervesce with acids, or with alcalies, or to change the colour of turmeric paper, it is then diſtinguiſhed to be a neutral, or a compound ſalt, compoſed of an acid, and another baſis, which are comprehended under the ſecond general diviſions of ſalts.

By theſe ſalts we have firſt to aſcertain the order to which they may belong.

EXP. II.

A little of the ſalt is diſſolved in diſtilled water, and a few drops of a well ſaturated ſolution of pruſſiate of ſoda or potaſh, are added, if a copious precipitate takes place, and likewiſe with mild ſoda, it then turns out to contain metallic parts, and belongs to the ſalts called METALLIC SALTS, which conſtitute the firſt order of the neutral ſalts.

ORD. I.

EXP. III.

Next we have to determine the genus to which it belongs, by aſcertaining the acid by which its baſis is neutraliſed; for this end, we add to a little of the ſaturated ſaline ſolution, an equal portion of ſpirits of wine; if this occaſions the ſalt to ſeparate, and if a few drops of muriate of baryt, added to a little of the diſſolved ſalt, occaſion a copious precipitate, we then know, that the acid is ſulphuric acid, and

and that the ſalt belongs to the genus called SULPHATES, of the metallic ſalts, which is the firſt genus of the firſt order of neutral ſalts. GEN. I.

EXP. IV.

Laſtly, we have to aſcertain the baſis, or with what kind of metallic oxyd, that acid has combined, by which we determine the ſpecies; for this purpoſe we add firſt liquid mild ammonia to it, if SPEC. this occaſions a blue precipitate, which is rediſſolved again, by a greater portion than what is neceſſary to ſaturate the acid, we then place a ſmall narrow and poliſhed plate of iron, into the diſſolved ſalt, which is put into a narrow wine glaſs, and let it ſtand for a little while; if the ſurface of the iron plate becomes covered with reddiſh metallic particles, then we have found that the ſalt had copper for its baſis, and this being neutraliſed with the ſulphuric acid, which was before aſcertained, makes it to be that ſpecies which is called SULPHATE OF COPPER. SPEC. I.

This ſalt exhibits alſo a blue colour, which may be conſidered as one of the marks by which it may be ſuſpected.

EXP. V.

But if theſe phenomena are not perceived, and the ſalt has a greeniſh hue, we add a few drops of pruſſiate of ſoda to the diſſolved ſalt, when this occaſions a copious blue precipitate, the baſis is then ſuppoſed to be iron, and in this caſe, it alſo muſt produce a black colour, when mixed with infuſion of galls. Thus we have aſcertained the component parts which characteriſe it to be that ſpecies called

SPEC. 2. SULPHATE of IRON, or MARTIAL VITRIOL.

EXP. VI.

If neither of theſe phenomena is obſerved, and it exhibits a roſe colour, we add a few drops of infuſion of galls; if this occaſions a blue precipitate, and occaſions a precipitate with potaſh, which when fuſed with borax

borax before the blowpipe, produces a blue glafs, we then have afcertained the bafis of the falt to be cobalt, and this combined with the fulphuric acid before afcertained, makes it to be that fpecies, called SULPHATE of COBALT. SPEC. 3.

EXP. VII.

But if neither of thefe marks is perceived, and the falt being white, we place a polifhed plate of copper into the diffolved falt, and this occafions a white metallic precipitate upon the furface of the copper, which can be volatilifed again by ignition, and frefh lime water being added to a little of the faline liquor, occafions an orange yellow precipitate, we then know the bafis to be mercury, having afcertained the principle component parts of the falt, which is diftinguifhed by the name of SULPHATE of MERCURY. SPEC. 4.

EXP. VIII.

If the ſalt does not prove any of theſe mentioned properties of mixture, and it be a white ſalt, if pruſſiate of alcali added to it, produces a precipitate of a greeniſh white hue, and if, iron and copper placed in the ſolution, occaſion no precipitate, we then ſuppoſe the baſis to be zink, and conſequently, the
SPEC. 5. ſubſtance to be the ſpecies called SULPHATE of ZINK.

Theſe are, as far as I know, all the metallic ſalts which have hitherto been found in the earth.

EXP. I.

If the ſalt to be examined, is found to be of a different nature, we have then firſt to aſcertain what order it conſtitutes, and for this end, we firſt add a ſolution of mild potaſh, or ſoda, and obſerve whether a copious precipitate takes place, if not, then the ſalt
ORD. II. belongs to the ALKALINE NEUTRAL SALTS, which are comprehended under the ſecond order of neutral ſalts.

We

We have next to examine the acid by which its baſis is neutraliſed, and hence we aſcertain the genus under which it may be comprehended, in our order for this purpoſe.

EXP. II.

We firſt add a few drops of muriate of baryt, if this occaſions a copious precipitate, and if ſpirits of wine added to a concentrated ſolution of the ſalt, occaſion a ſeparation of the ſalt, we then know, that the neutraliſer is ſulphuric acid, and conſequently, the ſalt belongs to that which comprehends thoſe ſalts called SULPHATES of ALKALINE SALT, and which conſtitutes the ſecond order of the neutraliſed ſalts. GEN. I.

EXP. III.

Next we have to determine the baſis of the ſalts, by which the acid had been neutraliſed, and hence we aſcertain the ſpecies; for this end, we mix an equal portion of pure lime, commonly called quicklime, or we may add pure

or

or caustic potash, if it occasions a volatile, pungent, or strong sensation to the olfactory organ, the basis is then proved to be

Spec. 1. ammoniac, commonly called volatile alkali, and the salt constitutes that species of alkaline neutral salt, distinguished by the name of SULPHATE of AMMONIA.

EXP. IV.

If the salt belonging to the second order, does not occasion a precipitate, on adding nitrate of baryt; and if it does not occasion a copious precipitate, when sulphate of silver is added to its solution, it is then sup-

GEN. II. posed, that its basis is neutralised by nitric acid, and that it thus belongs to the genus called NITRATES.——In order to ascertain the species.

EXP. V.

A little of the salt is thrown into a red hot crucible, and observed whether it defla-

grates

grates or diſſipates, if not, it is then mixed with charcoal, and thrown into an ignited crucible, if it deflagrates, it then proves to be common nitre, or NITRATE of POTASH, which conſtitutes the firſt ſpecies of the NITRATES. SPEC. I.

EXP. VI.

But if this ſalt produced no precipitate with the nitrate of baryt, but occaſioned a copious precipitate, when mixed with the ſulphate of ſilver, it is then proved, that the baſis is neutraliſed by muriatic acid, and conſequently, conſtitutes the genus, which comprehends the ſpecies called MURIATES. GEN. III.

EXP. VII.

In order to aſcertain the ſpecies, a little of it is mixed with pure lime, or cauſtic potaſh, and rubbed together in a ſtone mortar, with a little moiſture; if it emits an elaſtic matter, which affects the olfactory organ ſtrongly, if it it precipitates a ſolution of platina; and if it is volatile when ſtrongly heated in cloſe veſſels, it then proves that the baſis of the

Spec. 1. ſalt is ammonia, and conſtitutes the ſpecies called MURIATE of AMMONIA.

EXP. VIII.

But if theſe phenomena are not perceived, and if it is not ſoluble in ſpirits of

Spec. 2. wine, the baſis is then ſuppoſed to be ſoda, and conſtitutes the ſpecies called MURIATE of SODA.

EXP. I.

If the ſalt to be examined, occaſions no precipitate, by adding pruſſiate of alcali to it, nor any with metals, but a copious precipitate with a ſolution of mild potaſh or ſo-

ORD. III. da, it proves then to have an earth for its baſis, and conſequently, belongs to the third order, namely, the EARTHY NEUTRAL SALTS.

EXP.

EXP. II.

GEN. I.

In order to aſcertain the genus, we muſt determine the acid by which the earth is neutraliſed; for this purpoſe, we firſt diſſolve the ſalt in diſtilled water, as uſual, and add to a little of it, a few drops of muriate of baryt, if this occaſions a copious precipitate, and if ſpirits of wine occaſion a ſeparation when added to the ſolution, we then know that the neutraliſer is ſulphuric acid, which conſtitutes the genus called SULPHATES.

EXP. III.

We next proceed to aſcertain the earth, or its baſis, to determine the ſpecies. There are two ſpecies of ſulphates of earths found; the one contains a ſuperabundant acid, affecting the colours of litmus paper, having an aſtringent taſte, and when added to an infuſion of certain vegetable ſubſtances, which contain much colouring matter, ſuch as logwood, and

and the roots of the rubia tinctorum, its earthy basis is partly precipitated along with the colouring matter; and when the salt is decomposed by a solution of potash, the thus precipitated earth when calcined a little, becomes afterwards insoluble in acetous acid,
SPEC. 1. and also in diluted nitric acid. This species containing the argillaceous earth, is called ACIDULOUS SULPHATE of ALUMINA, or ALUM.

The other species has a bitterish taste, and has not that property of separating the fine colouring matter from vegetables. It is perfectly neutralised. Acid of sugar, or concentrated sulphuric acid added, forms no selenite; and when the salt is decomposed by a solution of potash, the earth thus separated,
SPEC. 2. when calcined, remains soluble in nitric and acetous acid; and when rubbed with moistened rhubarb powder, it changes its colour reddish; this earth is called magnesia, and the salt, SULPHATE of MAGNESIA.

In this manner, we may ascertain the different salts which have hitherto been found amongst the mineral products. There are other salts found, contained in mineral waters, but they are generally mixed with several kinds

kinds of ſalts, and muſt be aſcertained in a different way.

The ſalts which I have treated of, are only ſuch as are found each in a ſeparate ſtate, and which appear homogeneous when cryſtalliſed.

We now proceed to the mineral products, which conſtitute the ſecond CLASS, including in general, thoſe mineral ſubſtances which are chiefly compoſed of earths.—They are not ſoluble in water, in the proportion like the perfect ſalts; their earthy component parts, when in a ſeparate ſtate, ſhow hardly any, or no diſpoſition to fuſe *per ſe*, even after having been ignited with charcoal; nor do they produce fixed air, when ignited with charcoal, in cloſe veſſels, after having been ignited *per ſe*. They are not inflammable *per ſe*, nor conſumable in fire, nor have they a metallic luſtre, and their ſpecific gravity never exceeds five times that of diſtilled water. All the ſubſtances belonging to this claſs, we ſhall divide into nine different genera, according to the nature of their prevalent component parts.

The earths which conſtitute the principal component parts of each of theſe genera, have been aſcertained to differ from each other, in certain properties, as mentioned in the beginning of the firſt volume.

But as we find that many ſubſtances belonging to either of theſe genera, bear ſome reſemblance to each other, I have endeavoured to trace out ſome marks and properties, by which we may be enabled to aſcertain certain mineral ſubſtances, (without reſolving them into all their conſtituent parts) ſo far as to bring them under certain diviſions, and in order to facilitate the inveſtigation of a ſubſtance, which may occur to thoſe who are beginners in the ſtudy of mineralogy, and who wiſh to arrange minerals in a ſyſtematical manner, according to the arrangement which I have now adopted.

I ſhall begin with thoſe genera, which comprehend ſuch ſubſtances, as on account of their ſuperior degree of hardneſs, or coherency, &c. are leaſt liable to natural decompoſition, or alteration, and which are leaſt acted upon by the nitric, muriatic, and ſulphuric acid, and thereby diſtinguiſhable from the other ſix genera.

There are two ſubſtances lately aſcertained, which turn out to contain an earth for their principal component part, differing from the other earths; but as theſe ſubſtances in their

combined

combined ſtate, bear ſome reſemblance to certain ſubſtances belonging to the genus called the ſiliceous genus, and as theſe are very ſcarce and ſeldom occur, and there being only one ſpecies of each as yet known, we may therefore for the preſent, ſatisfy ourſelves with the deſcription which I have given of them, in the firſt volume, page 56 and 57, mentioning thoſe marks by which we may diſtinguiſh them.

GEN. I.

The firſt genus, the ZIRCON follows in hardneſs the ſaphyr, hyacinth and emerald, but is harder than rock-cryſtal, and in ſpecific gravity, it exceeds all other ſtones which are of the ſame hardneſs; it is not fuſible *per ſe*, in fire, nor acted upon by acids, nor ſoluble by ſoda. Its regular ſhape is the octahedron, but the tetrahedral pyramids on each end are ſeparated by a priſm. The principal earth of which it is compoſed, is found ſoluble in ſulphuric acid, and the ſolution exhibits on evaporation, a gelatinous maſs.

GEN. II.

The other ſubſtance which conſtitutes the ADAMANTINE GENUS, is equal to the foregoing as to hardneſs, but it has a ſparry appearance and texture, and differs alſo from the other ſtones which reſemble it, as to hardneſs and refractory nature in fire; it is not ſo tranſparent, and only ſlightly ſemi-tranſparent, as far as I could obſerve of the various ſpecimens, which are in the valuable collection of the Right Honourable Mr. Greville. It is not acted upon by the ſulphuric, nitric, or muriatic acid, and has altogether a different appearance from the other ſtones, which it reſembles as to ſpecific gravity and hardneſs.

I ſhall now trace out ſome marks, and the qualities of thoſe ſubſtances, which we may bring under certain diviſions or ſections, belonging to the ſiliceous genus, not the moſt accurate, becauſe they may, according to certain analyſes, contain not all a prevalent portion of the ſiliceous earth, but becauſe their other appearances and quality coincide more with thoſe in which the ſiliceous earth is found to predominate. If, for inſtance, the ſubſtance which is to be examined, is a very hard body, but differs from the appearance and quality of the two before mentioned ſubſtances, we then examine, whether it has all the appearances and qualities which are mentioned aſunder, and which all thoſe ſubſtances exhibit, as are comprehended in either of the ſections of the ſiliceous genus.

SILICEOUS

SILICEOUS GENUS. GEN. III.

Sect. 1.

They are tranſparent, have a colour and vitreous appearance, and a high luſtre; they ſcratch rock cryſtal; their ſpecific gravity exceeds three times that of diſtilled water of 60° temperature of Fahr. ſcale, which is taken for a ſtandard as 1,000. They are not fuſible *per ſe*, in a heat = to that required for fuſing iron. They are not acted upon by the ſulphuric, nitric, or muriatic acid, even when heat is applied in their entire ſtate; they are not ſenſibly diminiſhed by fuſing them with ſoda.—Such are for example: *Saphyr—Ruby—Oriental Topaz—Hyacinth-chryſolith*, and *Beryl*.

Sect. 2.

They are alſo tranſparent—are of an inferior ſpecific gravity, not fuſible *per ſe* in a heat = to that required for fuſing copper; they are ſcratched by the ruby, but they fcratch flint and petrofilex, and ftrike fire with fteel. They are not fenfibly acted upon when entire, by the aforementioned acids. They effervefce with foda. Such are e. g. *Emerald—Olivin Rock Cryftal,* and the *Tranfparent Quartz.*

Sect. 3.

They are more or lefs fufible *per fe*—they are fcratched by rock cryftal (except the perfect garnit)—they fcarcely ftrike fire with fteel; they fcratch heavy fpar and fluor fpar—they are more or lefs inclined to opacity, and if they are more tranfparent, they all fufe or melt eafily *per fe*, by means of the blow-pipe, and may be further afcertained by the external appearance, &c. by which the different fpecies differ from each other. They all exhibit a regular fhape, or marks of it when entire.—They are more or lefs acted upon by the three aforementioned acids, when heat is applied, and when previoufly reduced to fmall particles —Such are—the *Garnit—Shorl-Zeolith*, the *Semitranfparent Fieldfpar*, and *Horneblende.*

SECT. 4.

They are ſemitranſparent in different degrees—they do not fuſe *per ſe* in the heat which thoſe of the third ſection fuſe in—moſt of them ſtrike fire with ſteel. They are not, or at leaſt very little acted upon by acids. They have a cloudy or milky appearance. They exhibit no perfect cryſtalliſation, or regular ſhape, or at leaſt ſeldom—they are all leſs hard than rock cryſtal—they are not opaleſcent, or do not reflect light in different colours, e. g. *Calcedony Flint* — *Cornelion* — *Cryſopraſs* — *Solid Amorphous Quartz,* and *Shade.*

SECT. 5.

They are opaleſcent, or reflect different colours on account of their peculiar texture; they are only ſemitranſparent; they do not ſtrike fire with ſteel, and their ſurface can be ſcratched by rock-cryſtal and calcedony. They become opaque in fire, and are a little acted upon by acids when aſſiſted by heat, e. g. *Opals Catſeye.*

N. B. The *Labrador* ſpar, and *Adularia*, exhibit alſo theſe marks of opaleſcency; but theſe, with regard to their other qualities, belong more properly to the fieldſpars.

Sect. 6.

They are of the hardneſs of calcedony, and more or leſs ſemitranſparent; they are generally found in nodular pieces of no regular figure; they exhibit diſtinct clouds or ſtripes of different colours or ſhades—the ſtripes are rectilinear and parallel, or concentric, or otherwiſe curved, e. g. *Agats—Onyxes—Sardonyx*, &c.

Sect. 7.

They are opaque; ſtrike ſlightly fire with ſteel, and when reduced to fine powder, and boiled with concentrated ſulphuric acid, the acid becomes partly ſaturated, and when mixed with water, leaves on evaporation, alum or acidulous ſulphat of alumina, e. g. *Jaſpers Pétroſilex—Baſaltes.*

Neither of theſe mentioned ſpecies has a diſtinct foliated texture, nor are they elaſtic;—they are all more or leſs brittle, and do not adhere to the tongue, nor do they diſcover any clayey ſmell when breathed on (except the horneblende) nor do they neutraliſe potaſh when melted or boiled with it.

Sect. 8.

There are others which poſſeſs more properties of thoſe ſubſtances which are comprehended under the Siliceous Genus, than of thoſe which belong to the Argillaceous Genus, with which they are generally ranked on account of the prevalent component parts, but they differ from the other ſubſtances of the Siliceous Genus, in having a diſtinct foliated texture, which may be eaſily divided into thin leaves, which are flexible and elaſtic—they are not readily acted upon by acids, and do not ſtrike fire with ſteel, e. g. *Mica*; and theſe may therefore conſtitute a ſeparate Section.

(Many

(Many other ſtones, or ſtony ſubſtances, may properly belong to the Siliceous Genus, but conſiſt of different ſubſtances which have not intimately combined together, and which are only blended, cohering by ſimple attraction or power of coheſion; or they are cemented by other heterogeneous ſubſtances. Theſe ſubſtances generally form rocks, and are to be ſeparately examined, and treated.)

If we find that the ſubſtance to be examined, does not exhibit the appearance and properties of the ſubſtances which were diſtinguiſhed in the foregoing Genera, we then proceed to compare the appearance and qualities which characteriſe it to belong to another Genus of earthy ſubſtances, namely, GEN. IV. to the next Genus in our Order.

ARGILLACEOUS GENUS.

Subſtances which we ſhall comprehend under this Genus, may be diſtinguiſhed by the following general appearance and qualities:

They

They are almost entirely destitute of transparency; they exhibit no regular shape, or they have no crystallised appearance; they have mostly an arid and opaque appearance, and no particular or vitreous lustre like those of the foregoing genus. They emit all a peculiar smell when breathed upon, a smell, which we commonly distinguish by the name of a clayey smell; they are all more or less acted upon by acids, and the sulphuric acid extracts the argillaceous earth, of which they are mostly composed, in the state of alum. They are naturally not hard—none of them strike fire with steel—and their surface can be scratched with a knife, with fluor spar—and many of them suffer impressions by the nail of a finger; they become all hard, and more tough in fire; the softer kinds absorb water rapidly, and retain it strongly; but when exposed to a very intense heat, they contract, and many of them, particularly those of the purer kind, become so hard, that they strike fire with steel.

There are other substances which are of a harder nature, and which form whole rocks, or part of rocks; but these being more of a heterogeneous nature, they are to be examined and distinguished by the means which I shall mention in the divisions of different rocks.

If

If a ſubſtance is found, whoſe appearance and properties coincide, or at leaſt nearly, with the deſcription above mentioned, we then have to aſcertain whether it may properly belong to this genus, reſpecting its prevalent earthy conſtituent part. For this purpoſe we take a ſmall quantity of the ſubſtance, which is to be examined, and expoſe it in a crucible, with a ſmooth ſurface, and made of clay (ſuch as are made at Mr. Wedgewood's manufactory); the crucible is then put into a furnace, and gradually heated, until the crucible and the ſubſtance become juſt red hot. It is then taken out and reduced to a fine powder. Two hundred grains are then put into a glaſs matraſs, and digeſted with nitro-muriatic acid, as long as the acid takes up any of the ſubſtance; the whole is then put upon a filtre, and the reſiduum collected, dried, and heated in the aforementioned way, and its weight aſcertained.—It is marked A.

The ſolution is then mixed with pruſſiate of lime or ſoda, until no more precipitate enſues; the precipitate is then likewiſe collected upon a filtre, dried, and its weight aſcertained, and marked B. it is the metallic part. The filtered liquid is then mixed with a ſolution of ſoda, until no more precipitate is perceived.

This

This is then likewise collected, and washed upon a filtre, and is then nearly dried and put into a matrass, and digested with strong sulphuric acid, as long as it is found to take up any of the substance; the whole is then put upon a filtre, and washed with warm water, mixed with a little spirits of wine; the filtered liquor is then diluted with water, and the earth all separated from it, by adding a solution of potash to it; the precipitate thus produced, is again collected upon a filtre, and deprived of the saline parts by washing it upon the filtre with a little warm water, it is then dried and put into a crucible, and ignited for half an hour, after which it is taken out, put into a glass matrass, and digested with two or three ounces of distilled vinegar for several hours; after this, the whole is put upon the filtre, and washed with a little water; the residuum is dried and heated, and its weight ascertained.—Its weight must exceed the half of the quantity of the substance which was thus examined; it is then the argillaceous earth, and the substance belongs thus to the Argillaceous Genus.

In order to bring the substances which belong to the Argillaceous Genus, under certain divisions, we must particularly attend to the texture,

texture, coherency, tenacity, hardneſs, and ſpecific gravity, ſenſation to the touch, to the quantity of moiſture which they abſorb, and the retentive power uſeful for the examination of ſoils—to the taſte—to the degree of ſmell which they emit when heated, and the alteration they undergo by different degrees of heat, whether they occaſion a deflagration when mixed with nitre, and thrown into an ignited crucible—and to the proportion in which they are ſoluble in ſulphuric, muriatic, and acetous acid, and the proportion of iron they contain, and in what ſtate, and the mixture and proportion of heterogeneous bodies. If we find that a ſubſtance does not coincide with all or moſt of thoſe marks and qualities, we then compare it with the characters of bodies which are comprehended under another Genus, namely, the

MAGNESIAN

MAGNESIAN GENUS. GEN. V.

The ſubſtances which belong to this genus, may be diſtinguiſhed as follows:

As to appearance, they have almoſt all a more or leſs glittering or ſhining ſurface, ſeldom, if at all, an earthy appearance, except the earth which conſtitutes the principal component part of the ſubſtances belonging to this genus, when in a pure and unconcrete ſtate. They hardly ever exhibit a regular cryſtalliſed ſhape. Their texture is generally ſcaly or lamellar, fibrous, filamentous, lignious, or ſhivery, ſeldom they have an even texture, and ſeldom more than a ſemitranſparent one, they are generally inclined to opaque. Their ſubſtance are almoſt all more or leſs ſmooth and ſoft, or ſoapy to the touch; they do not generally adhere to the tongue, nor ſtain the fingers.— They may be cut with a knife, or with a machine; they do not ſoften in water like clay; they diſcover no clayey ſmell by breathing on them; they do not generally exceed in ſpecific gravity the rock cryſtals, but are commonly light.

light. They do not, or very ſeldom, effer-veſce with acids; but they are more or leſs acted upon by them, when reduced to powder, and boiled with the ſulphuric acid; the acid then extracts the magneſian earths, and becomes thereby neutraliſed, forming a ſalt which has a bitteriſh taſte, which has no diſpoſition for deliqueſcency, and differs from alum as the ſalt, which is extracted from argillaceous ſubſtances by that acid—has an aſtringent taſte, and contains generally a ſuper-abundant portion of acid; the cryſtals of alum are alſo much harder, and when broken, have a more vitreous appearance.—The magneſian ſubſtances do not contract, or harden, or fuſe in fire like clays, except they are mixed with ſilex, in which caſe they melt, or when mixed with any of the other earths; they do not effervеſce with borax before the blow-pipe, and they give a milky appearance, and diminiſh the tranſparency of other vitrifiable ſtones or mixtures; they are not ſoluble in ſoda, nor produce glaſs with potaſh by fuſion when freed from ſilex. When expoſed to a ſtrong heat and cooled, they are not ſoluble in water, nor emit heat like the calcareous ſtones. They do not diſcover any acid when fuſed with potaſh, like ſome ſubſtances belonging

belonging to the calcareous genus, viz. *Selenite.* Thefe are the moft general marks and qualities which the fubftances of the genus exhibit and poffefs.

In making different divifions of the various fubftances belonging to this genus, we muft notice the texture, coherency, hardnefs, tenacity, the different degrees in which they are affected by different acids, and the proportion in which they are foluble, as well as the fubftances left behind by digefting them with acids, and the alteration they undergo in fire.

There are other ftones belonging to this genus, which exceed all the other fubftances of the genus, both in hardnefs and gravity; but they form rocks, and come therefore under that head.

We then come to the examination of thofe fubftances which differ from all thofe mentioned, and which belong to another genus.

The CALCAREOUS GENUS. GEN. VI.

The fubftances which this genus comprehends, contain calcareous earth as their principal component part; but this earth is frequently found blended or combined with different ſubſtances which alter its appearance and quality greatly, and hence we find it difficult to bring the ſubjects under one general head. I ſhall therefore endeavour to point out the way, and the order in which they may be examined and aſcertained; I mean ſuch as may be brought under certain ſections. We ſhall for that purpoſe divide this genus, 1ſt. into ſuch ſubſtances as are readily ſoluble in nitric acid, with more or leſs efferveſcence; 2d. Into ſuch as are not ſoluble in nitric acid, or at leaſt more difficult than the foregoing, and which do not efferveſce, and which have at the ſame time, almoſt generally a ſparry appearance.

In order to aſcertain thoſe which belong to the firſt general diviſion, we proceed in the following way:

1ſt. The ſubſtances which we find to efferveſce with nitric acid, and to be ſoluble in it, and which are either of an earthy or of a ſparry texture; theſe we have to examine whether they contain calcareous earth, as there are other ſubſtances which may reſemble the calcareous ſubſtances in ſome appearance and quality; for this purpoſe we take a little of the

the nitrous ſolution, and dilute it with about 24 times the bulk of diſtilled water, and add gradually diluted ſulphuric acid to it; if a copious precipitate is produced, we then know that the ſubſtance contained baryt earth; but if none or hardly any precipitate is thus produced, we then take another portion of the ſaturated nitrous ſolution not diſtilled, and add gradually concentrated ſulphuric acid to it; if this occaſions a copious precipitate, we then know that the ſubſtance contains calcareous earth, and may thus belong to the calcareous genus, and to thoſe calcareous ſubſtances, which are combined with fixed air. In order to aſcertain whether it may properly belong to this genus, we muſt aſcertain the proportion in which the calcareous earth is contained in it, as it may be mixed with other earths. For this purpoſe we take a certain portion, *e. g.* 200 grains, theſe we digeſt with nitric acid, as long as the acid will take up any of the ſubſtance; we then filtre the ſolution, and collect the reſiduum upon the filtre, dry it, and weigh it—marking it A. After this we dilute the ſolution with 24 times the bulk of diſtilled water, and add gradually diluted ſulphuric acid, as long as any precipitation enſues; when no more precipitation takes place (or perhaps

 none)

none); we then filtre the ſolution, and collect the precipitate upon the filtre, dry it, and aſcertain its weight, and mark it B.

We then add as much of a ſolution of mild ſoda to the liquid, as any precipitation takes place——it is then put aſide until the precipitate has ſubſided to the bottom of the glaſs veſſel (the veſſel may be of a conical ſhape, narrower at the bottom); we then decant the clear liquid, and waſh it repeatedly out with warm water, until it diſcovers no more ſaline taſte. After the water is nearly ſeparated from the precipitate, we then add again as much concentrated ſulphuric acid, as is neceſſary to ſaturate or neutraliſe the earth; after this, the whole is to be mixed with a mixture of three parts of diſtilled water, and one part of ſpirits of wine, in the proportion of 8 parts of this mixture to the quantity of the ſubſtance which was before diſſolved in nitric acid; this mixture will diſſolve all the ſaline parts, and leave the ſelenite or ſulphate of lime behind, which is then collected upon a filtre, and edulcorated with a little of the ſame ſpirits of wine and water. The reſiduum upon the filtre is then well dried, and its weight aſcertained, and is marked C.

The

The ſaline liquor which paſſed through the filtre, is now ſaturated and decompoſed by a ſolution of mild ſoda, the precipitate edulcorated with water, well dried, and its weight likewiſe aſcertained, and marked D. Now if the ſubſtance thus examined belong to the calcareous genus, the third part of the weight of the ſelenite marked C. muſt exceed the weight of the remainder A. and of the precipitate B. and D. together.

If the ſubſtance which is found moſtly ſoluble in nitric acid with effervescence, bear a ſparry cryſtalliſed appearance, it may be nearly diſtinguiſhed by the ſpecific gravity, as the barytic ſpar exceeds in ſpecific gravity that of the calcareous; the ſpecific gravity of the aerated barytic ſpar, is always found to be above 3,000; and that of the calcareous ſpar, always leſs than 3,000, however, for the ſake of accuracy, the analyſis may be performed.—The calcareous ſubſtances thus aſcertained, may then be divided again, according to the different texture, ſhape, and mixture. Some kind is found impregnated with bitumen or petroleum.

Other ſubſtances which are found not, or not eaſily ſoluble in nitric acid, and which have a regular ſhape or a ſparry texture, and which can be ſcratched or ſcraped by the knife, and whoſe ſpecific gravity is under 3,000; ſuch we may examine in the following way:

A. If the ſubſtance has a fibrous or a lamellar texture, or is cryſtalliſed, and the chrystals are not cubical;

If its ſurface can be ſcratched by fluor, and ſcraped by a knife;

If it does not eaſily fuſe or melt;

If its ſpecific gravity is between 1,600, and 2,000;

If, when reduced to fine powder, and boiled in 500 parts of diſtilled water, it is found ſoluble, and the ſolution occaſions a precipitate when mixed with nitrate of ſilver; and if ignited with potaſh, it neutraliſes the potaſh, and forms ſulphate of potaſh; and if the reſiduum is then found to be calcareous earth; the ſubſtance is then aſcertained to be ſulphate of lime, commonly called *Selenite* or *Gypſum*, which may conſtitute a ſeparate diviſion of the calcareous ſtones.

B. If

B. If the ſubſtance has a cubical figure or fibrous texture;

If it fuſes eaſily *per ſe*;

If it is not at all acted upon by nitric acid;

If it emits ſtrong ſuffocating vapours, which corrode glaſs when mixed with an equal portion of ſtrong ſulphuric acid—and heated;

If it is not ſoluble in 500 parts of water;

If its ſpecific gravity is about = 3,144.

If it crackles and ſplits aſunder, when ſuddenly expoſed to a ſtrong heat, and emits a phoſphoreſcent light when ignited upon a red hot iron. If it ſcratches ſelenite and calcareous ſpar, it then is aſcertained to belong to the calcareous ſubſtances combined with the fluoric acid, commonly called *Fluors*, which conſtitute another diviſion of calcareous ſtones.

C. If the ſubſtance is partly ſoluble, when reduced to powder, and digeſted with pure nitric acid; and if the ſolution, when ſaturated, is precipitated by adding nitrate of lead.

If it is fuſible *per ſe*.

If it does not crackle when firſt expoſed to the blow-pipe, like fluor; and if it emits luminous ſparks when ſcratched with a hand knife in the dark; and its ſpecific gravity is = 3,218, it then diſcovers the marks and properties of the phoſphate of lime, called *Appatites*, which belongs to another divifion of calcareous ftones.

D. If a fubftance is fufible *per fe* ;

If it has a cubical figure with the angles or the edges, or both truncated ;

If it does not crackle when fuddenly expofed to heat ;

If its fpecific gravity is about 2,560.

If it is partly foluble in nitric acid, when previoufly reduced to powder, and digefted with it by heat; and when the folution faturated, and decompofed by a folution of alcali, the remaining liquid mixed with concentrated fulphuric acid, and evaporated to drynefs by a gentle heat, then digefted with fpirits of wine filtered, and the fpirits of wine evaporated ; if then a falt is left behind, which turns the litmus paper red, then the fubftance exhibits the properties of borat of lime, called *Boracit.*

E. If a fubftance is found by examination to contain calcareous earth, diftinctly blended with other fubftances, it comes then under the head of rocks, or other blended ftones.

BARITIC GENUS. GEN. VII.

The ſolid ſubſtances belonging to this claſs, are particularly diſtinguiſhable by their ſuperior ſpecific gravity, in which they exceed almoſt all other ſtones which are now known, and which are only of ſuch hardneſs as will admit of being ſcratched with the knife; they emit no ſmell when breathed upon; they do not eaſily vitrify *per ſe*, nor with ſoda, and have a ſparry appearance; they are leſs hard than quartz. All ſubſtances belonging thus to this genus, may be divided into two general ſections. The one A, is totally ſoluble in nitric, and muriatic acid, but almoſt only when in the diluted ſtate; they are not acted upon by ſulphuric acid; when diſſolved in nitric acid, the earth or baſis can be ſeparated from that acid, even when the ſolution is diluted with 24 times the quantity of diſtilled water, by diluted ſulphuric acid. The earth when pure, and ſtrongly ignited in a crucible, becomes very little ſoluble in water. When diſſolved in nitric, or muriatic acid, and neutraliſed, it yields cryſtals on evaporation, which are not diſpoſed to diliqueſce like the earth of the afore

afore mentioned three genera. The ſpecific gravity of theſe ſparry ſubſtances, is above 4,000. The other ſection of ſolid ſubſtances belonging to this genus, have a lamellar texture; their ſpecific gravity is likewiſe above 4,000, or at leaſt near to it. They are not acted upon by any acid; when fuſed with borax, they immediately diſcover a phoſphorescent light. They are not ſoluble in 500 times the quantity of water.

They neutraliſe potaſh when fuſed, or ſtrongly ignited with it in a crucible, and form thereby ſulphate of potaſh, leaving an earth behind, which is ſoluble in nitric and muriatic acid, and which poſſeſſes the properties mentioned in the foregoing ſection.

The ſubſtances thus aſcertained to contain baryt earth, muſt likewiſe contain a prevalent portion of that earth, to belong properly to this genus.—The different ſpecies may be diſtinguiſhed according to the texture, ſhape, and mixture.——There is another ſubſtance lately found, whoſe principal baſis proves to conſtitute a new genus of earth, which has ſome reſemblance to the baryt earth, it is called

STRON-

STRONTHIONIT GENUS. GEN. VIII.

Of this genus, there is but one ſpecies as yet known. Its ſpecific gravity is above 3,000; it is ſoluble in 800 parts of warm water. It is ſoluble in nitric acid of the ſpecific gravity 1,300, or 1,200, with efferveſcence; alſo in the muriatic acid, and its baſis can be precipitated from theſe acids, by diluted ſulphuric acid, to which it has an inferior chemical attraction than baryt, but a ſtronger attraction than calcareous earth; when ſtrongly and ſufficiently heated, it loſes its fixed air, and does afterwards no more efferveſce with nitric acid.

When diſſolved in acids, and precipitated again by a ſolution of potaſh, and ſtrongly ignited, the earth is then ſoluble in water of 70 temperature, in the proportion at leaſt, of 1 to 180, but much more ſo by boiling water, and in the latter caſe, part of the earth ſeparates in the ſtate of cryſtals, which are again ſoluble in water. Cryſtals procured from this earth, by the combination with nitric acid, detonate in an ignited crucible, and the

the earth fuſes with an equal part of ſilex. The earth when ſtrongly ignited, and mixed, when cooled, with cold water, emits a greater heat than baryt earth, and has a ſtronger attraction for fixed air than baryt, as Mr. Kirwan has obſerved.

Several of theſe mentioned, and other properties of this peculiar earth, have been obſerved by Dr. Hope, who has communicated to the public, an extract of his ingenious paper; in the laſt volume of the Edinburgh Tranſactions.

The next claſs of mineral products, includes the metallic ſubſtances. How theſe are to be diſtinguiſhed from each other, and from other ſubſtances, I have already endeavoured to explain in this volume, and which, as well as the reſt of this work, I ſhall endeavour to improve by proſecuting the plan, of which I have given a ſketch in this appendix, and which I ſhall communicate in a ſupplement to this work.

OF

ANALYSIS

OF

MINERAL SUBSTANCES

IN GENERAL.

IN the examination of minerals we find ſometimes earthy ſubſtances which contain different ſalts, blended or mixed, and partly in the ſtate of ſuch ſmall parts, that their proportion to each other, cannot be determined by ſorting and collecting them all in the mechanical way, or by picking, and theſe muſt therefore be aſcertained by more accurate

and

and chemical proceſſes. How this may be done, I ſhall illuſtrate by a mere example.

Suppoſe we had aſcertained by previous experiments, (in the way I have mentioned in the foregoing part, in which I have treated of ſimple and compound ſalts) that an earth contained a mixture of different ſalts, as *ſulphate of magneſia*, *muriate of potaſh*, *ſulphate of iron*, *ſulphate of potaſh*, and *ſulphate of ſoda*; we then may proceed in the following way: A certain quantity of ſuch earthy ſubſtances which has been previouſly dried for two hours, in the heat of boiling water, is extracted and freed from the ſaline parts, by digeſting it with about 50 parts of diſtilled water, in a glaſs matraſs; after which the whole is put upon a filtre, and the liquor thus ſeparated, the remainder upon the filtre is waſhed with a little water, then dried in the ſame heat, and for the ſame time as before, and its weight aſcertained, which indicates by the loſs, the quantity of ſaline parts which were contained in it. A certain quantity of the ſaline liquid is taken, evaporated to dryneſs by a gentle heat; this is firſt digeſted with high rectified ſpirits of wine, as long as the ſpirits will diſſolve any of the ſalt. This ſpirituous ſolution is then mixed with a little pure water, and freed from the ſpirits of

wine

wine by diſtillation ; the remaining aqueous ſolution is then evaporated nearly to dryneſs, and expoſed to cryſtalliſe, the ſalt is then dried in the ſame degree of heat as the earth had been expoſed to, its weight will indicate the proportion of the ſalt which was taken up by the ſpirits of wine, and which was MURIATE of POTASH; this ſalt may be again aſcertained, by diſſolving a little of it in pure water, when liquid ſulphate of ſilver added, will occaſion a precipitate which indicates the muriatic acid, and potaſh added to it, will occaſion no earthy precipitation, if the ſalt was merely compoſed of muriatic acid and potaſh. The ſalt which was not diſſolved by the ſpirits of wine, is then to be diſſolved with a ſufficient quantity of diſtilled water, and a little acetous acid added, then liquid pruſſiate of lime is gradually dropped into it, until it does not occaſion any more blue precipitate. The precipitate thus formed, is collected upon a filtre, which is to be waſhed with a little pure water, dried and made juſt red hot in a ſmall crucible, whoſe weight is previouſly aſcertained, and which had been made red hot *per ſe*, before the precipitate was put in ; after which, the crucible is taken out of the fire and weighed,

thus

thus the proportion of the calx of iron is ascertained.

The remaining liquid from which the iron was now separated, is gradually mixed with acetate of baryt, as long as any precipitate is thereby occasioned, which consists then of the baryt contained in the acetous solution which was added, and of the sulphuric acid contained in the salts; the whole is then put upon a filtre, the precipitate carefully collected, dried, and its weight ascertained, 100 grains of such precipitate, are very nearly calculated to contain 30 grains of sulphuric acid.

The remaining solution, consisting now of *magnesian earth, potash and soda, and acetous acid*, is then evaporated to dryness, and ignited in a smooth crucible, until the acetous acid has been driven off by the heat; the remaining substance is then extracted by distilled warm water, as long as the water takes up any of it; the whole is then put upon a filtre, and the earth, which was the magnesia, is collected, dried, ignited, and its weight ascertained.——The salt which the water has separated from the earth, is then again saturated with acetous acid, and if stirring the saturation, any earthy precipitate is observed, it is to be filtered again, and the earth collected upon

upon the filtre; it is the portion of magneſia which had been taken up by the alkaline ſalt, which is likewiſe to be dried and added to the weight of the firſt magneſia.

The filtered liquid is then evaporated by a gentle heat to dryneſs, and afterwards digeſted with ſpirits of wine. This will take up the potaſh combined with muriatic acid, and leave the ſoda behind; the diſſolved ſalt, by ſpirits of wine, is then evaporated to dryneſs, and re-diſſolved in diſtilled water; it is then mixed with acetate of lead, until all the muriatic acid is thereby ſeparated; the precipitated muriate of lead is then ſeparated by filtration, and the filtered liquid evaporated to dryneſs; afterwards ignited a little in a ſmall ſmooth crucible, whoſe weight has been previouſly aſcertained; when the acetous acid has been driven off by heat, the crucible is taken out, and when cooled, it is immediately weighed, and the overplus of the weight of the crucible, will indicate the weight of the potaſh. The muriate of ſoda, which was not diſſolved, is likewiſe treated in the ſame way, and thus the quantity of the ſoda aſcertained.

Now we may take each of the four ſeparated ingredients, namely, the magneſia, ſoda, potaſh, and the iron, and ſaturate each ſeparately with the ſulphuric acid, and have them cryſtallifed; by that means we then can aſcertain the quantity of each of the ſalts in the ſtate as they were contained in the earthy ſubſtance, pretty accurately.

This being a nice proceſs, requires great accuracy; yet it ſhews how ſuch decompoſition of ſubſtances can be proved, both by analyſis and ſyntheſis, and how much the improvement of chemiſtry has enabled us to do.

In the analyſing of earthy ſubſtances or ſtones, we may firſt attend to the ſorting of ſuch ſubſtances as have a ſparry texture and appearance, or which exhibit a regular figure, and are leſs hard than Quartz, *and to ſuch as efferveſce with nitric acid; there we have firſt to examine, whether they may owe their ſtate and ſtructure, &c. to an acid. For this purpoſe we may try them in the following way:*

1. We reduce a certain quantity to powder, and try whether it efferveſces with nitric acid; if ſo, we then take, for inſtance, 100 grains, and put them into a retort, of as little capacity as poſſible, to which the ſmall pneumatic apparatus is adjuſted, with a graduated receiver to aſcertain the bulk of the gas which is collected in it. Vide the annexed plate.

N. B. The water with which the receiver is filled, may be previouſly mixed with a little ſulphuric

phuric acid, to prevent the abſorption of fixed air when this paſſes through the water, as it ſtands over it.

A ſufficient quantity of muriatic acid of a middling ſtrength is then put at once through the opening at the top of the retort, and immediately ſtopped, ſo as to be air tight; when the effervefcence which takes place, has perfectly ceaſed, then the air ſtill in the retort, and in its neck, is alſo let into the other gas collected in the receiver over the water, and the bulk of the whole gas is aſcertained by the meaſure which is indicated by the ſcale on the receiver.

A ſufficient large piece of burned lime, ſuch as does not effervefce with diluted ſulphuric acid, is then put upon the perforated cover which is to be ſcrewed to the mouth of the receiver (as exhibited by the figure in the annexed plates of the receiver) which is ſtill kept under water, and ſhaked occaſionally; as ſoon as the lime which is in contact with the water in the receiver, becomes diſſolved in it, and abſorbs the fixed air which is contained in the receiver above it, it falls to the bottom in the ſtate of mild lime; by ſhaking the receiver a freſh part of the pure lime will be taken up by the

 water,

water, and thereby a freſh portion of fixed air abſorbed. When no more abſorption and precipitation takes place, and all is cooled to the temperature of the atmoſphere, then the loſs of the whole bulk of air in the receiver, will be obſerved by the ſcale on it, and the loſs indicates the quantity of fixed air which had lodged in that quantity of the ſubſtance which had thus been examined. One cubic inch is very near equal to one grain of common medicinal weight, this way may be ſufficient to aſcertain the quantity of fixed air; and if we proceed in the ſame manner with different ſubſtances, the reſults muſt proportionally correſpond; we may indeed calculate the quantity of fixed air of a ſubſtance thus tried already, pretty nearly from the quantity of gas which is firſt collected in the receiver, provided we are convinced that the earthy body thus treated, contains no other ſubſtance; as for inſtance, metallic parts, vegetable or bituminous matter, which might thus by means of the acid, yield alſo a different gas, and which would conſequently make the calculation erroneous or inaccurate; we may expect metallic matter, if the ſubſtance is coloured, vegetable matter when it deflagrates with nitre in the way before mentioned, and

and bituminous mixture by the ſmell when rubbed or heated.

But if the ſubſtance which is to be examined has a ſparry texture, is not acted upon by the nitric acid, and is leſs hard than quartz, we then may firſt examine the ſubſtance, whether it contains a mineral acid, either the fluoric or the ſulphuric, which often occurs, and with what baſis they are combined.—In this caſe we examine it according to the manner I have deſcribed before, whether it belongs to the *fluors*, *ſelenites*, or *ponderous ſpars*; if we find it to belong to the baryts or ſelenites, its component parts, and their proportion to each other, may be aſcertained in the following way: 100 grains of the ſubſtance, which has been previouſly reduced to a fine powder, may be mixed with 200 grains of purified alcali, (if heavy ſpar 300 grains) and ignited together in a crucible (made of clay) for half an hour; after this the maſs is taken and waſhed out of the crucible, and boiled with 12 times the quantity of diſtilled warter, and put upon a filtre, where the remaining earth is to be edulcorated with diſtilled water, perfectly dried, and its weight aſcertained, it is then marked A.

If the filtered liquid proves to be alcaline, it may be ſaturated with muriatic acid; and if after the ſaturation, a precipitate is obſerved, it muſt be collected upon a filtre, and added to the other earth A.

The ſaline liquor is then diluted with a little more water, and gradually mixed with muriate of baryt, as long as that occaſions a precipitate. The precipitate is then collected upon a filtre, and well edulcorated, perfectly dried, and its weight aſcertained; 100 parts of ſuch precipitate, will very nearly indicate 13 parts of ſulphuric acid.

The earthy reſiduum marked A. is then to be diſſolved in diluted muriatic acid, and diluted with about two pounds of diſtilled water; diluted ſulphuric acid is then added as long as any precipitation takes place. The precipitate is collected upon a filtre, and after being edulcorated, well heated, and its weight aſcertained; 100 parts of this precipitate will indicate 70 parts of baryt earth, which was the quantity of the baryt contained in the mineral.

The ſolution from which the baryt had thus been ſeparated, is then evaporated to about four ounces; concentrated ſulphuric acid is added as long as any precipitation is obſerved; the whole is then heated and evaporated to about one ounce, and placed to cool; after

after which it is put upon a filtre, and edulcorated or waſhed with a mixture of diſtilled water, and one fourth of ſpirits of wine, and afterwards dried, heated, and weighed ; 100 parts of it will indicate 32 parts of calcareous earth. The remaining liquid is then ſaturated with a ſolution of purified potaſh, and if a precipitate enſues, it is collected upon a filtre, edulcorated and dried ; when mixed with ſulphuric acid, if it forms a concrete ſalt, which is not ſoluble in a mixture of three parts of water, and one of ſpirits of wine, it is then ſelenite, but if otherwiſe, it is again decompoſed by a ſolution of ſoda, and the precipitate collected and calcined for half an hour, and digeſted with diſtilled vinegar; what is diſſolved then by the vinegar, is magneſian earth ; and what remains undiſſolved, is argillaceous earth. This analyſis may therefore anſwer for ſelenites and heavy ſpars.

If the earthy ſubſtance or ſtone which is to be analyſed, is found not to contain ſulphuric, or fluoric, or boracic, or phoſphoric acid, or ſaline parts, or combuſtible non-metallic ſubſtances, we may conduct an analyſis in the following way :

Firſt we have to aſcertain whether the ſub-ſtance effervеſces with acids, and whether this is occaſioned by the eſcape of *fixed* air—if ſo, the fixed air may be aſcertained in the way before mentioned—if not, 200 grains of the ſubſtance are reduced to a fine powder in an agate, or any other very hard mortar, and ſtrongly heated by a certain heat, to ſeparate the moiſture; the loſs of weight is thus mark-ed; it is then put into a glaſs matraſs, and di-geſted with nitro muriatic acid, (mixed of equal parts of nitric and muriatic acid) as long as the acid will take up any of the ſubſtance. The whole is then put upon a filtre, and edul-corated with water, and collected upon the filtre, afterwards dried in the ſame heat; it is then weighed; its loſs will indicate the quantity of the ſubſtance which had thus been diſſolved in the acid. The filtered ſolution is then put aſide, and marked A.

The remaining undiſſolved ſubſtance is then to be rubbed again in the agate mortar, and mixed with three parts of deaguated ſoda, put into a crucible of three times the capacity of the bulk of the mixture, and placed in the furnace, and covered with another larger cru-ble; heat is then applied until the outer cru-cible is become perfectly red hot, which is ſufficient

ſufficient for the purpoſe, as care muſt be taken to prevent the mixture from fuſing, otherwiſe the maſs may likely act upon the crucible, and thus introduce heterogeneous matter into the mixture.

The maſs which is found cohering, is then taken out, and reduced in the mortar to fine powder. The powdered ſubſtance is put into a cylindrical glaſs or matraſs, and firſt mixed with a little pure water; if the water exhibits a green, or amethyſt, or brown colour, then mangancſe is ſuſpected; freſh nitro muriatic acid is then poured on it, as much as is neceſſary to ſaturate the alcali, and to diſſolve every part which is ſoluble in that acid; the digeſtion is aſſiſted by a moderate heat (the digeſtion may be repeated with freſh acid.) The whole is then put upon a filtre, and the reſiduum ſufficiently edulcorated with water, afterwards dried by the ſame heat as before, and its weight aſcertained, it will be the ſiliceous matter or quartz; if this ſhould ſtill have a colour, it muſt be mixed again with ſoda, and treated in the ſame manner as before.

All the ſolutions in acid, if they contain too much predominating acid, ſhould be a little evaporated; and if during this a precipitate ſhould take place, a little ſugar is added to occaſion the

the precipitate to re-diſſolve if mangaueſe, or a few drops of muriatic acid, if iron. If the acid ſtill abounds too much, the ſolution is then nearly ſaturated with ſoda; liquid pruſſiate of lime, or ſoda, is then gradually added, until no more precipitate is occaſioned; the whole is put aſide for a few days to ſubſide; if in this time the coloured precipitate has not ſubſided, the liquid may be heated a little, which will then occaſion the ſeparation of the metallic precipitate; after this the whole is put upon a ſmall filtre; (made of writing paper, freed from ſize by boiling diſtilled water) and the precipitate, after being edulcorated with water, is carefully collected, dried, and ignited in a ſmall crucible for one hour; its weight is then aſcertained; if the precipitate could not be well ſeparated from the paper, the precipitate, together with the paper, is put into the crucible (100 grains of ſuch paper, leave generally one grain of reſiduum, which muſt then be deducted from the weight of the precipitate thus calcined.)

The calcined precipitate may now conſiſt of iron, copper, nickel, or mangaueſe. It is then firſt digeſted with mild liquid ammonia; this will take up the copper and nickel with a blue colour, if it contains any—if ſo, a poliſh-ed ed weighed plate of iron is put into the ſolution—the copper, if any, will then be found depoſited upon the iron in the metallic ſtate; if no copper is thus found, the liquid is then evaporated to dryneſs, and its weight aſcertained, it will then be the oxyd of nickel.

The reſiduum left from the extraction by ammonia, is likewiſe dried, and its weight aſcertained, it will be the iron; but if any mangaceſe is alſo ſuſpected, the laſt precipitate, namely, the ferruginous, is to be digeſted with a ſtrong ſaturated ſolution of pure or cauſtic potaſh, and expoſed to a heat nearly to boil; after which it is filtered, and the liquid left to cool and to ſubſide; the precipitate will be the manganeſe, which is then collected upon a filtre, waſhed and dried, and weighed; and the ſubſtance, which remained on the filtre before, is the iron.

The liquid collected by the filtration, from which the metallic parts had been ſeparated, is then to be examined and analyſed; for this purpoſe, a little ſulphuric acid is dropped into the ſolution; if this occaſion a white precipitate, baryt is ſuſpected; the whole is then mixed with two pounds of diſtilled water, and as much diluted ſulphuric acid is added, until no more precipitate is obſerved; the thus produced

produced precipitate, which conſiſts of the baryt earth and the ſulphuric acid, is collected upon a filtre, waſhed, perfectly dried, and weighed, 100 parts of the precipitate, will indicate near 70 parts of baryt, or to be more accurate, the precipitate may be decompoſed again by fuſing it with potaſh, whereby the potaſh will unite with the ſulphuric acid, and ſeparate the baryt earth, which may be deprived of the ſaline parts, by lixiviating it with boiling diſtilled water; the earth is then left behind, which is to be dried, and its weight aſcertained.

The liquid from which the baryt had been ſeparated, is then evaporated to about four ounces meaſure, and mixed gradually with concentrated ſulphuric acid, as long as any ſeparation of the ſolution is obſerved, the whole is ſuffered to cool if freſh acid is added, and this occaſions no more ſeparation; it is then put upon a filtre, and edulcorated with a mixture of warm water and ſpirits of wine, in the proportion as has been obſerved before, the ſelenite upon the filtre is then dried, heated, and its weight aſcertained, from which the quantity of calcareous earth, as was mentioned before, may be aſcertained by calculation, or 100 parts of ſelenite thus formed, contain near

30

30 parts of calcareous earth, or the ſelenite may be decompoſed by potaſh, as before mentioned.

The ſolution from which the ſelenite had been ſeparated, is then ſaturated, and decompoſed by a ſolution of ſoda, which will ſeparate the argillaceous and magneſian earth, if it contains any, which is collected upon a filtre, dried and ignited as uſual, and its weight aſcertained; after which, it is put into a ſmall crucible, and ignited for half an hour. The whole is then taken out, weighed, and put in digeſtion with diſtilled vinegar, which will gradually take up the magneſian earth, if any, and the argillaceous earth is left behind, which is dried and weighed again; by this means, the ſubſtance is analyſed in ſo far as we are able to judge from our preſent knowledge in chemiſtry.

As it is well known that gold is occaſionally found mixed with ſand, or earthy ſubſtances, often in the ſtate of ſo minute particles, that it cannot be diſtinguiſhed by the mere eye, we may for that purpoſe examine ſuch ſubſtances in the following way: Firſt, we may ſeparate the light and duſty parts of the earth or ſand, by waſhing it with water in a veſſel, and frequently decant the water immediately, after ſtirring

ſtirring it each time; ſome of the ſubſided parts muſt be well dried, and a little calcined, to ſeparate any combuſtible and volatile parts.

A certain quantity of the ſandy ſubſtances, or ſtone, is then reduced to a very ſubtile powder, and put into a matraſs; nitro-muriatic acid, or aqua regia is then poured upon it, and left in a warm digeſtion; when the acid is ſaturated, it is filtered, and tried whether a purple precipitate is occaſioned on adding a little of a ſolution of tin diſſolved in the ſame acid; if ſo, the whole ſolution may be mixed with ſulphate of iron, as long as any precipitation takes place; the precipitate will be the gold contained in that ſubſtance, which may afterwards be fuſed and purified by cupellation; the quantity of gold will indicate, whether it be worth while to continue the trouble and expence of the proceſs, for obtaining more.

Sometimes TIN is found mixed with ſand, or other ſtony ſubſtances. This may be diſcovered in the ſame way, by extracting a certain quantity of the pulveriſed ſubſtances with the nitro-muriatic acid, which takes up the tin, if any; a little of a ſolution of gold made by the ſame acid, added to the ſolution which is ſuppoſed to contain tin, will occaſion a purple

ple precipitate; if so, the ore may be analysed in the way I have mentioned, in that part of this volume which treats of tin ores.

Sometimes we find zink in the state of calx, mixed with stony substances, composed of silex, calcareous earth, oxyd of iron, and sometimes also lead. In order to analyse such stones, a certain quantity is reduced to a fine powder, and digested in a glass vessel, with twice its weight of nitric acid, by a little heat, the digestion is twice repeated with fresh acid; the whole is then put upon the filtre, and what remains upon the filtre, is washed with water, dried, and its weight ascertained;—it is the siliceous part of the stone.

The solution is then evaporated to dryness, and a little ignited in a crucible, after which, it is digested again with nitric acid, which takes up the other substances, and leaves the iron behind; after this, the lead may be separated by adding muriatic acid;—the calcareous earth by concentrated sulphuric acid, in the state of selenite.—The remaining liquid is to be decomposed by a solution of soda; the precipitate thus formed, is edulcorated, dried, and weighed.—It is the oxyd of zink which contains generally $\frac{1}{5}$ part of metal.

EXAMPLE

EXAMPLE

OF THE

ANALYSIS OF AN ORE.

THIS, we will suppose, we had found by previous experiments, to contain copper —lead—silver—iron—bismuth and sulphur.— In order to separate these different substances from each other, we may proceed in the following way: The ore is to be reduced to fine particles, and first digested and extracted with nitric acid, as long as it will take up any of the ore; the whole is then filtered, by which means, the SULPHUR remains on the filtre, which may be washed, collected, and dried between paper, in a heat not above that of boiling water, and its weight ascertained. If it it be pure ſulphur, it may be volatiliſed by a continued gentle heat. The filtered ſolution is firſt repeatedly diluted with diſtilled water, as long as any precipitate is occaſioned, this precipitate is collected upon a filtre, and dried. —It is BISMUTH.

The filtered liquid is then mixed with muriatic acid, as long as any precipitate is occaſioned; the precipitate is alſo collected upon a filtre; it is the SILVER combined with muriatic acid, from which the ſilver may be ſeparated, by mixing the precipitate with two parts of dry ſoda, and fuſing it in a crucible; by this means, the acid leaves the ſilver, and unites with the ſoda, and thus the ſilver is found reduced, and its weight may then be eaſily aſcertained.

The remaining ſolution is evaporated to about four ounces bulk, and ſulphuric acid is added as long as any precipitate is occaſioned; the precipitate contains the lead which was in the ore, and which may be ſeparated from the ſulphuric acid by ſoda, in the ſame way as the ſilver.—Thus the LEAD is ſeparated.

The remaining ſolution is then further decompoſed by ſaturating it with mild ammonia, which occaſions the iron to ſeparate, and keeps the copper in ſolution; the precipitate is then calcined, and its weight aſcertained.—It is the IRON.

Laſtly, the ſolution may be decompoſed by mixing it with a ſolution of potaſh, and boiling it a little; by this means, the ammonia is ſeparated, the potaſh combines with the acid, and the copper is precipitated.—Thus the COPPER is obtained, and the analyſis is finiſhed.

EXPLA-

EXPLANATION

OF

TABLE I.

TAB. I. Fig. 1. Cube with a ſtriated ſurface, viz. *ferruginous pyrites.*

Fig. 2. Cube with the angles truncated, viz. *galena.*

Fig. 3. Cube with the angles largely truncated.

Fig. 4. Cube with its angles and edges truncated, viz. *boracit.*

Fig. 5. Rhomb.

Fig. 6. Dodecagon, viz. *ferruginous pyrites,* or *mundik.*

Fig. 7. Dodecagon, viz. *garnets.*

Fig. 8. Polyadron, with 24 facets, viz. *volcanic garnet.*

Fig. 9. Four ſided pyramid, viz. *white zink ſpar, &c.*

Fig. 10. Hexahedral pyramid.

Fig. 11. Double tetrahedral pyramid, viz. *balais* and *ſpinel ruby, pyrites.*

Fig. 12. Double hexahedral pyramid, viz. *calcareous ſpar, Eaſt Indian ſaphyr, topaz,* and *ruby.*

Fig. 13. Tetrahedral pyramid, with the angles, and one ſide edge, truncated.

Fig. 14. Tetrahedral priſm without pyramids.

Fig. 15. Hexahedral priſm, having the ſides longitudinally ſtriated, viz. *aquamarin,* and certain kind of *calcareous ſpar.*

Fig. 16. Tetrahedral priſms, having ſome angles truncated, and ſome ſide edges and end edges doubly and obliquely truncated, viz. *Saxon topaz.*

Fig. 17. Tetrahedral priſm, on both ends bevelled or cuniated.

Fig. 18. Hexahedral priſm, acuminated on one end, or terminating gradually in a point, having the ſurface ſtriated acroſs, or tranſverſally, viz. *quartz cryſtal.*

Fig. 19. Double hexahedral pyramid, having the two oppoſite broad ſides of each end bevelled, or cuniated.

Fig. 20.

Fig. 20. Tetrahedral prifm, bevelled in the fame manner.

Fig. 21. Tetrahedral prifm, with a tetrahedral pyramid, which is obtufely truncated, &c. *Zircon.*

Fig. 22. Hexadral prifm, with a hexahedral pyramid, the bafis of which corresponding with the fide faces of the prifm, and the fides of the prifm are tranfverfally ftriated, viz. *rock cryftal, fpar,* but without *ftriae.*

Fig. 23. Tetrahedral rhomboidal prifm, varioufly truncated, *vide, Brafil topaz.*

Fig. 24. Tetrahedral prifm, accuminated on both ends, the facets are rhomboic, and proceed from the fide edges of the prifm, viz. *hyacint.*

Fig. 25. Prifm with nine fide faces, obtufely truncated by three facets, viz. *turmalin.*

Fig. 26. Hexahedral prifm, accuminated by three facets. *Grey antimony, calcareous fpar, ruby filver ore.*

Fig. 27. Tetrahedral prifm, with tetrahedral pyramids on both ends, the bafis of which correfponds with the faces of the prifm.

Fig. 28. Tetrahedral prifm, with a tetrahedral truncated pyramid, having one fide edge of the pyramid, and one of the prifms truncated.

Fig. 29. Tetrahedral prifm, terminating on both ends in a tetrahedral pyramid, which proceed from the correfponding fides of the prifm, by double obtufe truncation.

Fig. 30. A flat hexahedral prifm, bevelled or cuniated on both ends, by two large faces, which proceed from the two oppofite acute angular edges of the prifm, which are flightly truncated.

Fig. 31. Hexangular plate.

Fig. 32. Rectangular plate from all fides, edges bevelled or cuniated.

Fig. 33. Rhomboic plate, bevelled in the fame manner, viz. *felenites.*

Fig. 34. Triangular plate, bevelled in the fame manner.

Fig. 35. Hexahedral plate, accuminated, &c. viz. *heavy fpar.*

Fig. 36. Crofs cryftal formed from two four fided rectangular plates, croffing each other by a right angle, having both ends bevelled and accuminated, viz. *crofs cryftal,* from Andreafberg on Harz.

Fig. 37. Two rhomboic bevelled plates joined together.

Fig. 38. Crofs cryftal.

Fig. 39. Crofs cryftal of the nature of fhörl, apparently formed from four tetrahedral

fhort

ſhort pyramids, which are joined by their points and ſide edges.

Fig. 40. Croſs cryſtal from Compoſtella, *vide* page 75, Vol. I.

Fig. 41. Lenticular cryſtal, oval on both ſides.

Fig. 42. Lenticular cryſtal, whoſe edges are truncated, and the two ſides exhibit one rectangular face in the middle, and four pentangular faces around it.

Fig. 43. Goniometer for meaſuring the angles of cryſtals, exhibiting the indication of the angle of a rhomboidal cryſtal, which is placed between the inſtrument, as it is to be applied.

EXPLANATION

OF THE

DIFFERENT APPARATUS,

EXHIBITED UPON

THE DIFFERENT ANNEXED PLATES,

TAB. II, III, IV,

As may be required for examining and analysing Mineral Subſtances.

SECT. I.

FOR

POUNDING or PULVERISING.

FIG. 13, Tab. II. An iron mortar of a middling ſize, for dividing large maſſes of minerals into ſmaller pieces, to render ſuch convenient for examination, and more fit for pulveriſing pulverifing them further in fmaller ftone mortars, fuch, *f. e.* as (Fig. 16, Tab. II.) which are made in Mr. Wedgewood's manufactory, and which are very hard, and made of fuch materials as are not (or at leaft hardly) acted upon by the acids and alcalies commonly ufed for chemical decompofition.

Thefe ftone mortars are, in moft cafes, more convenient than glafs mortars, which are too brittle.

A fmall mortar (Fig. 17, Tab. II.) of agate or flint, is very ufeful to reduce fmall portions of very hard ftony fubftances to very fubtile powder.

Fig. 15. A fmall fieve to feparate the powder from the coarfer pounded particles, and to procure the particles of nearly equal fize. The fmaller the particles, the more eafily they are acted upon by folvents.

SECT. 2.

FOR DIGESTION, SOLUTION, &c.

Fig. 14, Tab. II. A graduated glafs meafure, for meafuring moderate quantities of liquids

liquids uſed for ſolution, divided into cubic inches, ounces, and to indicate a certain number of grains, which may exceed 100 grains, as ſmaller portions muſt be weighed.

Fig. 2, Tab. II. A conical glaſs, the inſide terminating in an oval bottom, for putting a ſmall piece of a mineral ſubſtance in, to try the action of acids upon it, having a ſmall ſolid thin bar of glaſs for ſtirring.

Fig. 1, Tab. II. A glaſs matraſs of about 8 or more ounces meaſure capacity, for digeſtion, and diſſolution of ſolid bodies in liquids.

Fig. 7, Tab. II. The ſame veſſel placed into a copper baſon *(b)* containing fine ſifted ſand, which is to be placed upon the cylinder of the lamp furnace.—Fig. 4, Tab. IV.

SECT. 3.

FOR

FILTRATION.

Fig. 5, Tab. II. Filtering apparatus, having a glaſs funnel (*a*) with four or ſix ſmall ſolid pieces of glaſs bent on one end, like

(Fig.

(Fig. *c)* hanged round the inſide, to prevent the filtering paper ſticking cloſe to the inſide of the funnel, which is placed in the cylindrical veſſel, *(b)*.

Fig. 6. A ſimilar filtering apparatus, but the funnel having a wider paſſage, to prevent any filtered liquid lodging in the tubular part of the funnel.

Fig. 8, Tab. II. APPARATUS for ſeparating deliqueſcent ſalts, from ſuch as do not abſorb moiſture enough to become perfectly liquid when expoſed in the atmoſphere.

(a) ſignifies a ſtand for holding the funnel *(b)*, which has a very ſhallow area, and a narrow tube *(c)*, terminating in a ſmall bottle *(d)* to collect the deliqueſced ſalt, which has been occaſioned by expoſing the ſubſtance, ſpread over the area of the funnel, in the atmoſphere.

SECT. 4.

FOR

PRECIPITATION.

Fig. 3, Tab. II. A long conical glaſs to put in a filtered ſolution for precipitation, which

which is to be covered by a thick plate of glaſs, as (Fig. 4.) to prevent the adventition of duſt.

SECT. 5.

FOR

EVAPORATION.

Fig. 9, Tab. II. A ſhallow glaſs, or ſtony veſſel, large enough to fit upon the cylinder of the lamp furnace,—Fig. 4, Tab. IV.—Under which, the Argand lamp, Fig. 5, Tab. IV, is placed.

Fig. 10, Tab. II. Small ſhallow glaſs veſſels, or watch glaſſes, for evaporating ſmall quantities, whoſe abſolute weight is marked on the outſide by a diamond. This is to be placed either upon the ring A of the apparatus, Fig. 18, Tab. II, at a proper diſtance over the cylinder of the lamp.

If a very ſmall and equal degree of heat is required for evaporating a ſmall portion of a liquid, I then place the ſmall glaſs veſſel upon the upper and narrower part of the earthen veſſel,

veſſel, Fig. 2, Tab. IV, which is open at both ends, and having holes through its ſides to allow the air a free exit; this apparatus, with the fluid, which is to be evaporated, is then placed upon the ſtand of the lamp furnace, and the ſpirit lamp, Fig. 3, Tab. IV, placed under it, and thus by turning the ſmall wheel of the lamp, the wick is raiſed at pleaſure, to regulate the flame, and conſequently the heat, according to the degree which is required; the cotton not being conſumed by the ſpirits of wine, like the wick of the oil lamps, or tallow candles, and therefore no ſnuffing being required for a very long time, until the lamp is freſh kindled, there is nearly an equal degree of heat for a conſiderable time, which is ſometimes required for very nice experiments; and as this lamp is not meant for producing a ſtrong heat, and the flame being very ſmall, it conſumes but a ſmall portion of the ſpirits.

When a liquid has been ſufficiently evaporated, which is to be cryſtalliſed, I then place it upon a ſtand under a glaſs-bell, Fig. 1, Tab. III, to prevent the adventition of duſt.

Large quantities of liquids, as in analyſing mineral waters, may be evaporated in large ſtone baſons placed over the furnace, Fig. 7, Tab. III.

SECT.

SECT. 6.

FOR

DISTILLATION.

Fig. 19, Tab. II. A retort *(b)*, which fits into the neck of the tubulated receiver, which reſt upon the plate of the ſtand *(d)*, the retort *(b)* is ſuſpended by the ring (A) of the ſtand, (Fig. 18). The ring (A) can be moved on the ſtick by the collar having a ſpring, and the receiver *(c)* can be raiſed by turning the ſcrew of the ſtand *(d)*.

The lamp, Fig. 20, Tab. II, is then placed under the retort, or the lamp furnace with the cylinder, Fig. 4, Tab. IV, may be placed under the retort, by means of which, the heat is directed to circulate better round the bottom of the retort; whereas without this contrivance, much heat is carried off immediately by the ſurrounding air, and only a certain part of the retort is heated at the time.

For diſtilling in the dry way, ſubſtances which require a ſtronger heat than what can be produced by the lamps; 1. in open fire: the

the earthen or glaſs retort coated with a proper clay (of ſand and argile) Fig. 7, Tab. IV, is placed in the wind furnace, Fig. 7, Tab. III, ſuſpended by the neck, which reſts in the ſide orifice marked *(b)*, on the upper part of one ſide of the furnace, to which retort a receiver may be adjuſted, whereby the retort is ſufficiently ſuſpended. The conical dome is then fitted over the furnace, in order to increaſe the draught of air, and to carry off the bad air and ſmoak through the chimney, which may be directed into a larger chimney of a room, or out of the window, juſt as is moſt convenient. The dome having a door marked by *(a)*, is very convenient to inſpect the fire, and to throw freſh fuel into the furnace.

Diſtillation on a moderate large ſcale, may be performed by placing a diſtilling apparatus in the ſame bath, as exhibited by Fig. 8, Tab. III, made of ſtrong iron plates, having likewiſe a chimney with a tube, which is to be placed upon the furnace, when the dome is removed, which ſerves likewiſe for digeſting large quantities of mixtures.

SECT. 7.

FOR

Collecting AERIAL FLUIDS, and for separating FIXED AIR, or CARBONIC ACID, from them.

The apparatus consists of a small tubulated phial, Fig. 5, Tab. III, having a bent tube, the end of which, immersed in the water contained in the tub, Fig. 2, and terminating under the cylindrical graduated receiver, Fig. 3, when the gas is all collected in the receiver, over the acidulous water, with which the cylinder was previously filled; then a bottom piece, Fig. 4, containing a sufficient quantity of slaked lime, is fitted to the lower part of the cylinder, and the whole well shaked together; the lower part of the cylinder is then immersed in water, and the stopper on the side of the bottom piece, is drawn out, to let in as much water as the bulk of the fixed air had previously occupied; the shaking is continued until no more absorption takes place. The loss therefore of the bulk of gas, which was indicated

indicated by the graduated ſcale on the cylinder, previous to the abſorption, will indicate the quantity of fixed air, which that quantity of the decompounded ſubſtance had contained.

If a mineral ſubſtance is found to contain no metal, and only fixed air, I make uſe of another method, which I found to anſwer the purpoſe, pretty accurately, and which is very eaſy.

I take a ſmall veſſel, (Fig. 6) conſiſting of a bottle mark'd *(b)*, and of a ſtopper terminating in a long tube which is perforated, and put in a ſufficient quantity of nitric acid, as will diſſolve 50 grains of carbonate of earth, and dilute the acid with water, ſo as to fill the half of the bottle, and weigh the whole accurately; I then put in 50 grains, or any ſmall quantity of calcareous earth, ſpar, or marl, put the ſtopper on, and give time for the fixed air to eſcape, the long tube of the ſtopper prevents the fixed air from carrying off moiſture, which will be the caſe, if the air is not made to riſe a ſufficient height. When the formation of fixed air has ceaſed, the whole inſtrument is then weighed again, and the loſs of weight, will indicate the quantity of fixed air which had been contained in that earth. It is

 better

better to put the ſpar or marl into the acid, in the ſtate of ſmall pieces, which prevents the ſudden action of the acid upon the ſubſtances, and the fixed air from ruſhing out too rapidly, and hence carrying off with it, a portion of moiſture.

SECT. 8.

USTULATION, or TORREFACTION, and OXYDATION of ORES.

Fig. 11, Tab. II. A flat, ſhallow, earthen, and unglazed veſſel, to which belongs a ſpatula, Fig. 12, made of glaſs, or hard ſtone ware, for ſtirring the ores, to accelerate the proceſs. The veſſel may be placed over the furnace, Fig. 7, Tab. III, and the heat to be applied, regulated by the regiſter marked by *(f)*, on the aſh-pit of the furnace.

SECT. 9.

FOR

FUSION, &c.

Fig. 7, Tab. III. A wind-furnace made of ſtrong iron plates, about twelve inches high from the aſh-pit to the top of the furnace, and about ſix inches wide, having a dome terminating in a tubular chimney, about two inches in diameter. The inſide of the furnace is lined with two coatings, the firſt, or next to the iron plates, is made of clay and pounded charcoals well beaten, and when this is dry, another coat of pipe clay, or a mixture of clay and ſand is applied over the firſt, ſo that the coats are about half an inch thick, which will reſiſt the action of the fire, and corroding vapours upon the iron, and confine the heat in the furnace, ſufficient to anſwer the purpoſe for fuſions, and other operations as may be performed ſuitable to its ſize, or quantity of fuel which it can hold.

The grate which is exhibited in the furnace marked by (*b*, Fig. 6, Tab. IV) has a ſtand of ſolid iron, or which may be made of the compoſition of which crucibles are made, having a flat top, with a ſlight impreſſion for the crucible, marked *(g)*, to ſtand upon ; the ſtand (of which two may be kept of different lengths) is faſtened in the middle piece of the grate. The crucible is better in many caſes, to be covered by another inverted one, to prevent the adventition of heterogeneous matter, and to collect the volatile parts.

When a fuſion is to be performed, the inſide of the furnace is laid out with long pieces of charcoal, placed in a perpendicular poſition upon the grate, by which contrivance, a greater draught is allowed for the air to paſs, and the heat is conſequently greatly increaſed. If a vehement heat is required, I then apply a pair of double bellows, Fig. 11, Tab. III, placed and faſtened by the two legs marked by *(a)*, upon a low table, the pipe of which is introduced in the hole indicated by (*f* of Fig. 6, Tab. IV) of the ſide of the furnace, a little below the top of the ſtand upon which the crucible is placed. If a moderate heat is only required, this can be regulated by the

regiſters,

regifters, or regulators, Fig. *g*, on the fide of the afh-pit of the furnace, Fig. 7, Tab. III, confifting of a folid flat piece of metal, having feveral holes through it, proportioned to each other, fo as to admit fuch quantities of frefh air, as may be neceffary; I have found this defcribed in the fourth edition of the Edinburgh New Difpenfatory, and it is much improved by Dr. Rotheram, a very eminent chemift of Edinburgh, whom Dr. Black has chofen as his affiftant, in his chemical lectures, much to the honour of that Univerfity, and greatly to the fatisfaction of his auditors.

Fig. 9, 10, and 11, of Tab. IV, reprefent a variety of crucibles, which may be ufed for many purpofes, fome of which muft be made of black-lead, a fubftance known not to be fufible, and particularly ufeful for fufing metals in it, which at the fame time, may affift to recover the metallic calces, by abforbing the calcining principle, with which it enters into combination, on account of its ftronger chemical attraction.

If cupellation is to be performed, I then place the other grate, Fig. 8, Tab. IV, in the furnace, fo as to reft upon the hooks (marked *d d* on the infide of the fire place) and

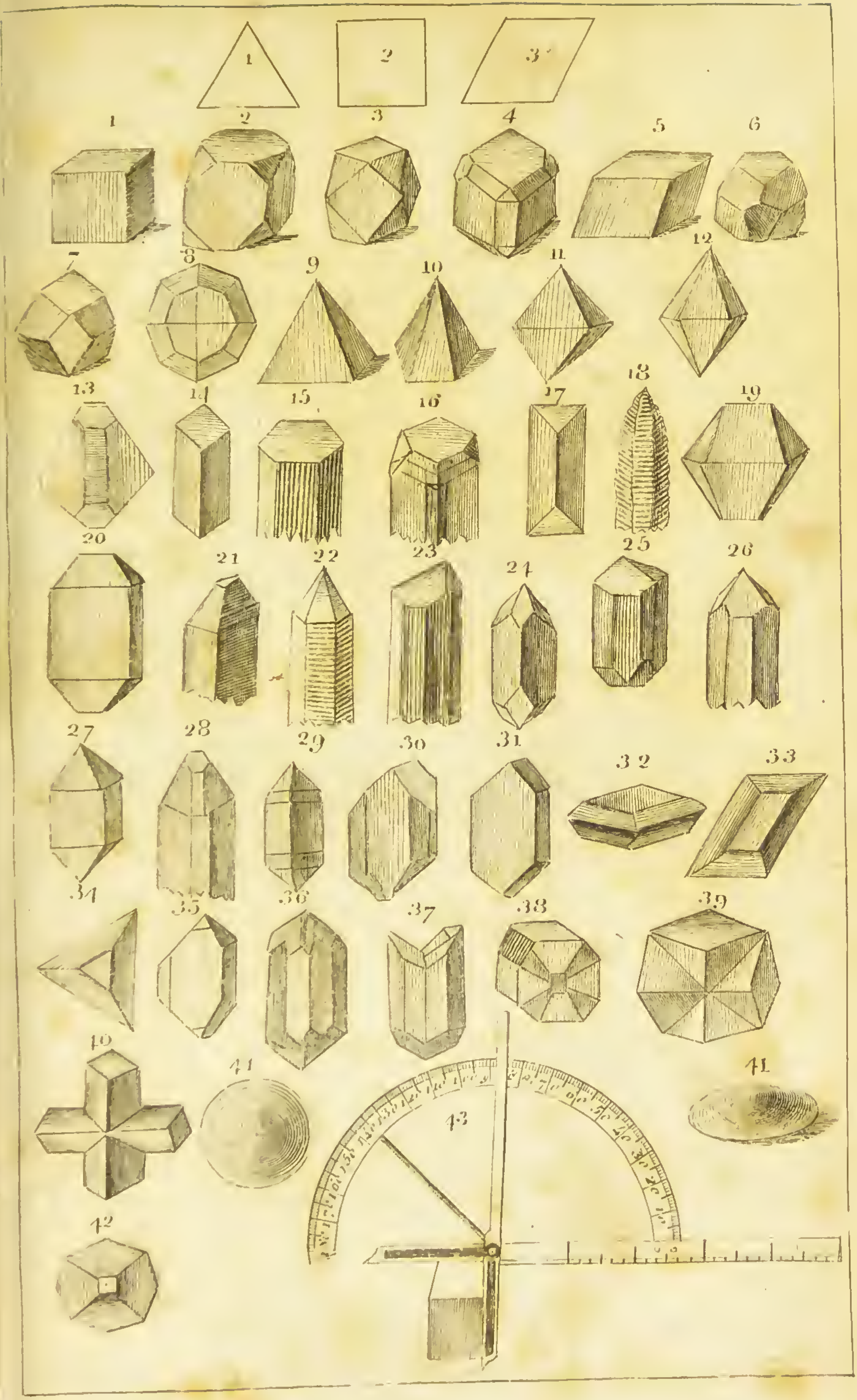
and upon the top of the ſtand of the lower grate, in the direction that the plate of the upper grate longitudinally faces the ſemicircular opening of the ſide of the furnace, exhibited by *e*, Fig. 7, Tab. III, which can be ſhut and opened when neceſſary, by a door *(d)*, having in the middle, a piece of ſolid metal to fit exactly into the opening.

The muffel, Fig. 9, Tab. III, in which the ſmall teſts or cupellæ, Fig. 10, are placed, is then introduced through the opening in the furnace, ſo as to reſt upon the upper grate, and the door ſhut; after which, the upper part of the furnace is filled with fuel, and ignited, and thus the proceſs may be performed with conveniency. A pair of tongs, Fig. 12, Tab. IV, are convenient for putting in, and taking out the teſts and crucibles, occaſionally through the apertures.

In the upper part of the ſide of the furnace, is a hole with a ſtopper of metal, through which freſh air may be admitted, or introduced by means of the bellows.

FINIS.

Tab. I.



Tab. II.

Tab. III.

TAB. IV